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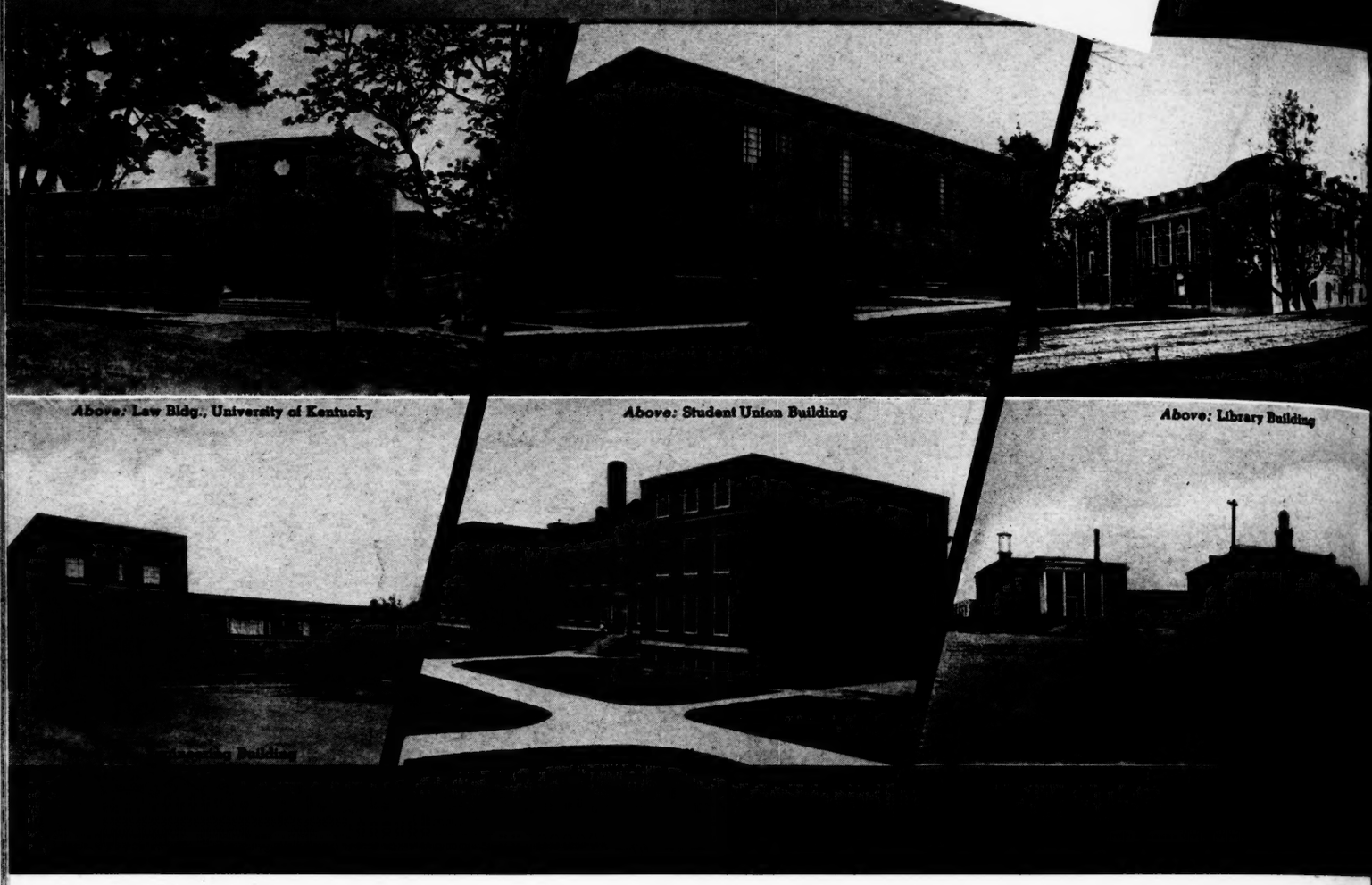
CONTROL BY JOHNSON



Above: Law Bldg., University of Kentucky

Above: Student Union Building

Above: Library Building

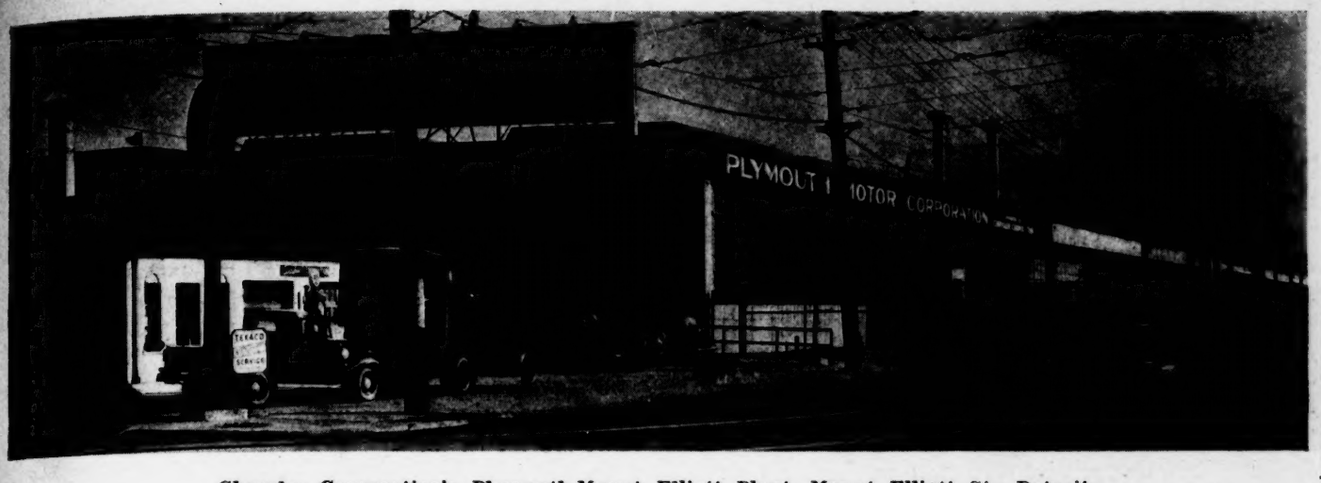
And the University of Kentucky, Lexington, is a good example! Johnson automatic temperature control, with individual thermostats in each principal room, is employed in the Teachers' Training Building, the Library, McVey Hall, and the Dairy Products Building. The other buildings, pictured here, and several others as well, are equipped with Johnson-controlled ventilating systems.

When the new central station heating plant was built, recently, Johnson Duo-Stats were installed as "master controllers" for almost every building on the campus. Twenty-seven of these unique instruments, operating to maintain the proper relationship between outdoor and heating system temperatures, insure steam economy and heating plant efficiency . . . The College of Engineering is responsible for the engineering work at the University of Kentucky.

Special devices are at work in the Tobacco Research Laboratory . . . Regardless of the problems encountered in automatic temperature and humidity control . . . heating, cooling, ventilating, air conditioning, special processing . . . Johnson engineers are prepared to supply the correct answer.

AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL FOR HEATING, COOLING, VENTILATING, AIR CONDITIONING AND INDUSTRIAL PROCESSES

JOHNSON SERVICE COMPANY



Chrysler Corporation's Plymouth-Mount Elliott Plant, Mount Elliott St., Detroit.

Exhaust Steam Heats Motor Car Plant

Long continuous pipe coils and hot water were used in this large automotive plant which was constructed and ready to operate in record time. Exhaust steam from the steam hammer equipment is used as a source of heat.

By F. O. JORDAN†

"HAMMER" steam, as exhausted from steam-driven trip hammers, is notably dirty and full of oil carried along from the cylinders of the hammers. In fact, hammer steam is so dirty and oil laden that it generally is considered unfit for heating service because of sad experiences resulting from attempts to use it in steam heating systems. However, the heat in hammer steam can be saved with the type of heating system used in the Plymouth-Mount Elliott Plant belonging to the Chrysler Corporation and located on Mount Elliott St., Detroit.

Heating with hammer steam is not the only unique feature of this heating system. One of these features is the use of pipe coils for heating purposes which are not far short of ¼ mile in length. You might think that ¼-mile coils would jump off the wall or tear the building down due to the irresistible force of contraction and expansion as they are alternately heated and cooled. However, although these particular coils were installed in their present locations before the great stock market crash of '29, they are there yet and give every evidence of being there to stay. So many of the existing industrial plants of comparatively recent vintage are heated by unit heaters with steam that a plant of this type heated by hot water may almost be said to be unique for this reason alone. If you wonder why a ten-year-old installation is used for illustrating industrial hot water heating, remember that this system

†Detroit Consulting Engineer and Mgr. of Edit. and Cons. Depts. of Refrig. and Air Cond. Inst., Chicago.

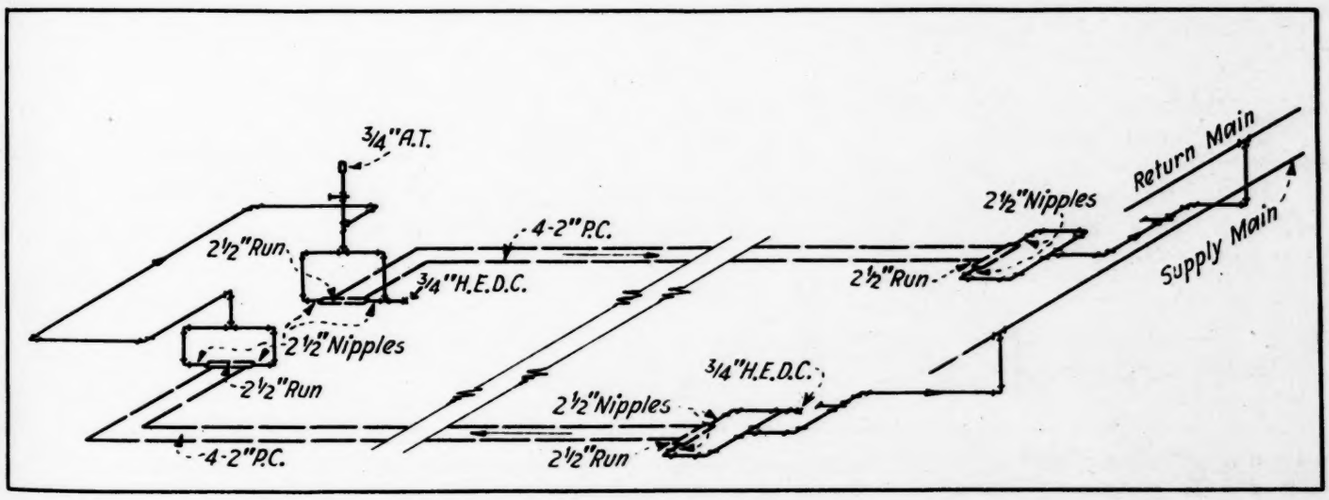


Fig. 1. Detail of typical office coils.

has been in operation long enough to tell a pretty complete story of its advantages and disadvantages in this particular type of application.

A 30-Day Wonder

You will remember that the '20's saw an almost unbelievable expansion of many American manufacturing industries. This expansion was especially prevalent in the automotive industry not only because of a widespread prosperity among people of average means but also because prices of automobiles fell steadily due to the development of mass production.

In the late '20's, Walter P. Chrysler thought he recognized a market for large numbers of low-priced, high performance cars, but realized the need of quick action. Orders were given to start work on an automotive plant of mammoth dimensions immediately as this plant was to be ready to start the production line rolling within not more than 60 days.

He visited architect Albert Kahn's place of business and asked when footing drawings could be delivered on the site of his contemplated factory. The answer was that they would be delivered in the morning. Sure enough, the next morning saw footing drawings delivered and waiting steam shovels spring into action. Thirty days later a Plymouth's horn tooted and the first car rolled from the assembly line under its own power, followed by an endless procession which has never been stopped.

While this sidelight story may not bear directly on the heating system installed during those hectic thirty days, it shows how little time the heating engineers had to consider job conditions and to decide upon the type of system.

Hot Water Heating Selected

At the time the plant was built, steam unit heaters had but recently come into their own for heating industrial buildings. Even though these unit heaters seemed to be in the ascendancy the engineers did not consider hot water obsolete for their purposes because of certain inherent advantages. One of these advantages is that even temperatures are easy to maintain throughout the entire heated area because water temperatures may be so readily varied to suit the existing outside weather. Another advantage was that hot water heating could be cheaply installed in this particular building, since it was considered unnecessary to insulate the hot water heating mains located inside the building and because short mains could be used.

Yet there are serious disadvantages to the use of hot water heating for buildings of this type. One of these is that very little circulation of air is obtained. This tends to result in air pocketing and stagnation that may be serious especially in departments where certain processes give off heavy oily or acid vapors. However, the principal disadvantage of hot water heating in the automotive factory is the difficulty of altering or extending the heating system when the building is altered or enlarged. In order to permit changes and additions to the system, oversized mains and plugged openings were installed so that branch mains could be installed for serving new additions without overloading the mains.

However, the fact that hot water could be installed cheaply while permitting the use of hammer steam caused this method to be selected in the end, regardless of any disadvantages.

How Hammer Steam was Used

The problem of saving the heat in the hammer steam was solved by using it for heating water in surface type water heaters with short tubing of large diameter. Thus troubles due to oil and dirt in the steam were localized in the water heater instead of being spread over the entire heating system as in a steam system. Actually there was no trouble due to this cause as the heating surfaces in the heaters were arranged so that oil and dirt are blown through quickly.

Description of System

The building is heated entirely by means of pipe coils through which hot water is circulated by motor-driven hot water circulating pumps. The roof and all monitors are blanketed by means of heating coils, many of which are approximately 1000 ft. in length. Heating coils are installed at the walls and under windows also. Coils are installed with 90° turns, and are supported on roll hangers to avoid strain and distortion due to expansion. The coils are arranged so that they generally are supplied and returned at the same end of the building so that the only mains necessary are comparatively short ones across one end of the building with connections to the ends of the coils. Since most of the travel of the water is through the long coils, long and costly mains are eliminated. Both the supply mains and the return mains are installed overhead where they are out of the way.

The circulating pumps of water heaters are installed in a separate pump and heater room. An open expansion tank is installed some distance above the highest part of the heating system for the purpose of eliminating air from the system and keeping it properly filled with water. Throttling valves for balancing water distribution through the system are installed at all branches. These valves are especially necessary for maintaining proper distribution in the system when extensions or changes are made.

The Test of Time

The operation of this heating system has been eminently satisfactory since the first day it was used both from the viewpoint of conditions maintained in the

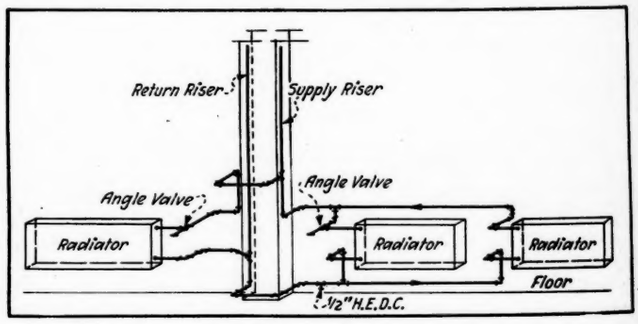


Fig. 2. Detail of typical radiator connections for single and double radiators.

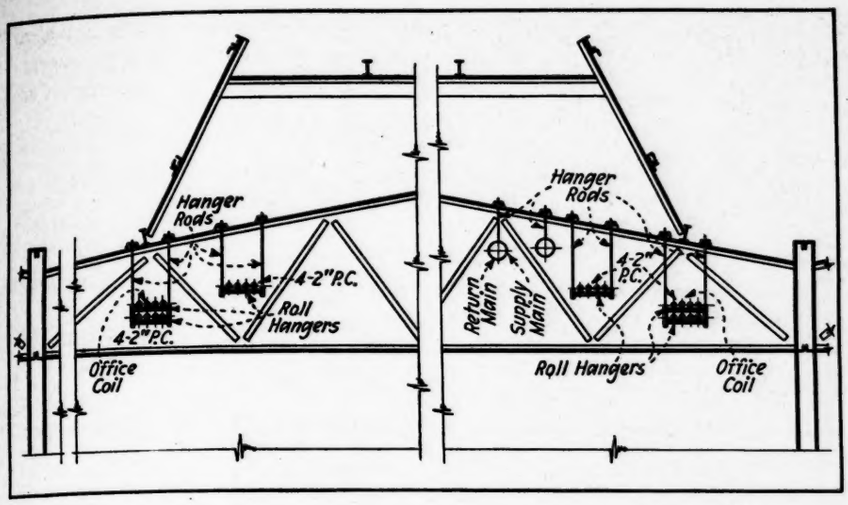


Fig. 3. Detail of pipe coils and mains in trusses.

building and from the limited service work required for maintaining it in good condition. Of course, the operating cost has been very low because steam for heating the water may be said to be practically free as it would be thrown away after operating the trip hammers if any other type of heating system were installed.

Even in the matter of altering the heating system to conform with building changes, less trouble has been experienced than might be expected. One reason that it has been possible to add to the heating system is that oversized mains and plugged openings were provided when the system was installed. By making supply and return connections to these openings for serving new and relocated pipe coils, and by adjusting throttling valves where necessary to obtain proper redistribution of hot water, it has been possible to conform the system to the requirements of building changes and additions without disturbing hot water distribution in the remainder of the system. When it has been necessary to supply outside air to take the place of air exhausted by new exhaust systems, air supply systems have been installed upon the roof. These supply systems have consisted in general of the necessary air circulating fans, blast heaters for heating the outside air to be introduced, and ductwork and registers for delivery into the building.

Design Methods

The methods used in designing this system are the conventional ones employed with buildings and heating systems of this type. For example, the usual overall transmission coefficients were used in estimating the heat lost by transmission. The heat for heating outside air entering the building by natural leakage or infiltration was estimated by assuming one air change per hour in outside bays, and one-half an air change per hour in inside bays.

The hot water distribution systems were designed in the conventional manner by sizing piping so that the pressure drop through all parallel circuits or water paths is practically the same. The final balance necessary for regulating distribution was made by manual adjustment of throttling valves. Piping was selected, and circuiting of pipe coils was arranged so that the total head upon the circulating pumps is equal to approximately a 100-ft. head of water. Pipe coils are based upon delivering 240 B.t.u. of heat per hr. per sq. ft. of heating surface.

Explanation of Figures

Fig. 1 shows the way in which the long heating coils were installed to prevent strain and distortion due to expansion and contraction. This figure also shows how long mains were eliminated by using the long pipe coils as circulating mains. In other words, water was supplied to one end of the long coil through which it was circulated to the other end of the building. Water was then taken from the coil and supplied to the adjacent end of the neighboring coil. The water was passed through this coil back to the return main located in the same end of the building as the supply main.

Fig. 2 shows the method of connecting the radiator to the overhead supply and return mains. Installation of the return main overhead made possible by the use of the forced circulation hot water heating system was an important factor in reducing the cost of the building because it eliminated underground tunnels and trenches for return mains that would have been necessary with a steam heating system.

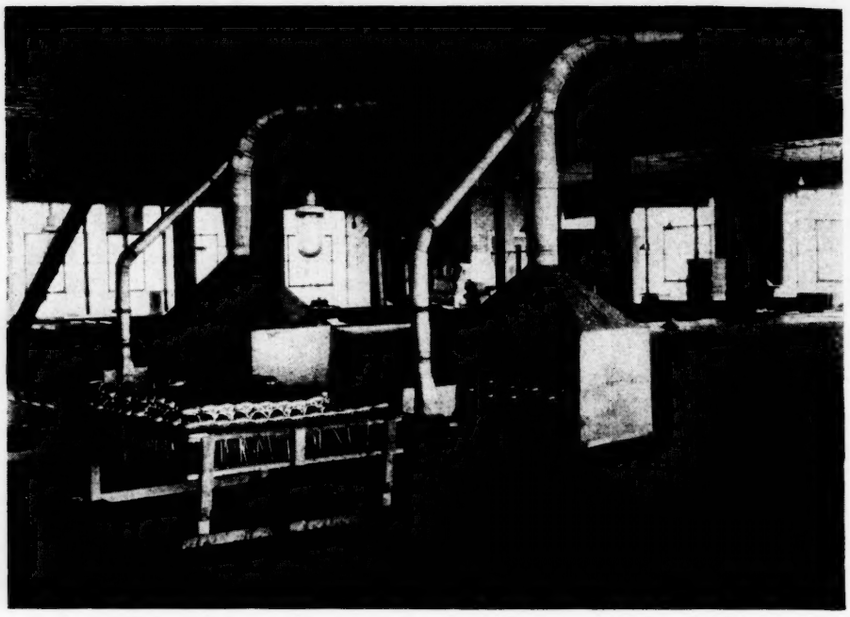
Fig. 3 illustrates the method of supporting the pipe coils overhead in the truss space on roll hangers.

Return of Chimney Sweep Predicted

RETURN of the chimney sweep in the modern role of a service man for the air conditioning industry was predicted by L. Logan Lewis, chief engineer of Carrier Corporation, in a recent address before the International Association of Fire Chiefs at New Orleans.

In discussing the necessity for clean ductwork as a means for fire control, Mr. Lewis said:

"Air conditioning people are regularly receiving an increased number of requests from owners of systems for the names of people who have developed the art of cleaning duct systems. Such people are gradually springing up and developing skill and technique and it is not unexpected that the chimney sweep will soon come back into his own."



Dipping Christmas tree ornaments. Note lateral ventilation at dipping tank and enclosed drying oven. This illustrates the canopy type spray booth. (Photos courtesy Div. of Industrial Hygiene, N. Y. State Dept. of Labor.)

Allowable Concentrations of Lacquer Constituents in Air

By WILLIAM J. BURKE, CH.E., and LEONARD J. GOLDWATER, M.D.†

Nitrocellulose lacquers, applied by spray guns or dip tanks, have practically replaced the hand brush in industry. Adoption of these new methods has resulted in possible health and fire hazards which, say the authors, can be most effectively controlled by adequate ventilation. In this article, abstracted from the New York State Department of Labor "Industrial Bulletin," the authors give data on the toxicity of these materials which can be used as the basis for the ventilating calculations.

THE term lacquer is derived from the word lac, a resin obtained from the lac tree found in the East Indies. The early Oriental varnishes contained this resin and were called lacquers, a term which is still frequently used to describe these products. At the present time the name lacquer is generally applied to coating products containing a nitrocellulose base, and such prefixes as "Chinese" lacquer or "Pekin" lacquer are added in referring to coating products of the old type. In this article the term lacquer is limited to coating products in which nitrocellulose is used as a base.

Today nitrocellulose lacquers (also called pyroxylin lacquers) are extensively used by contracting painters in the interior of buildings, by large factories, railroads and airplane plants; in the automobile industry, in the finishing of furniture, household fixtures and ornaments, and in leather finishing.

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The adoption of these new methods has resulted in a change in working conditions, with possible health and fire hazards necessitating the use of special precautionary measures.

The ordinary lacquer contains five basic ingredients, each of which has definite functions and also augments the properties of the other four, thereby giving a finished product of the desired characteristics. The ingredients and their functions are:

a. Nitrocellulose (or nitro-cotton) gives waterproofness, hardness and durability to the coating.

b. Solvents and diluents dissolve the nitrocellulose and gums and give quick drying properties, as well as prevent the finished film from blushing or turning white.

c. Gums or resins thicken the coated film and add to its adhesive properties.

d. Softeners or plasticisers overcome brittleness.

e. Pigments or coloring material give color to the finish and also reflect the actinic rays of sunlight, thereby making the coating more durable under outside exposure.

The volatile ingredients constitute about 75% by weight while the film or nonvolatile matter contributes about 25% by weight of the total.

Toxicity of Lacquer Constituents

The problem of the toxicity of lacquer fumes is one of increasing complexity. During the past few years a large number of new constituents whose toxic properties

are practically unknown have found their way into lacquer formulas. Very little is known about the possible deleterious effects of many of these substances. In discussing their toxicity, therefore, the various constituents are best considered under several headings, although it must be borne in mind that certain combinations of toxic materials may have actions of which the individual substances are incapable.

I. Solvents

A. Ester solvents. This group includes the acetic acid esters of methyl, ethyl, propyl, butyl and amyl alcohol. These substances are not known to produce any permanent damage to the human body under conditions of ordinary industrial exposure. Massive doses (in excess of 1,000 p.p.m.) may produce depression of the central nervous system, which would be manifested by lethargy, drowsiness, fatigue, loss of appetite and general lack of energy. It is also possible that high concentrations inhaled over a period of months may produce permanent injury, but no such cases have been reported.

Some of the other esters, such as cyclohexanyl acetates, alkyl glycol acetates, formic acid esters, diethyl carbonate and ethyl lactate are less commonly used than the alkyl acetates, and practically nothing is known of their possible toxic actions. The alkyl glycol acetates such as ethylene glycol monomethyl and monoethyl ether acetates are probably toxic in concentrations as low as 50 p.p.m.

B. Ketones. The ketones most widely used in lacquers are acetone, diacetone alcohol and cyclohexanone. Acetone is believed to be relatively harmless. Nothing is known about the toxicity of the other ketones, but they may act similarly to the alkyl esters if exposure is excessive.

C. Ethers. Ethyl ether is sometimes used in lacquers. The anaesthetizing properties of this solvent are well known. Some of the alkyl ethers of ethylene glycol are now commonly used in lacquers. This group would include the monomethyl, monoethyl and monobutyl ethers of ethylene glycol. Studies made recently by the Division of Industrial Hygiene indicate that the monomethyl ether of ethylene glycol is toxic in concentrations as low as 30 p.p.m. when there is exposure of several hours a day over a period of weeks. The toxicity is manifested by damage to the blood and to the central nervous system. It is reasonable to suspect that the other glycol ethers may have similar properties.

II. Diluents (nonsolvents)

A. Hydrocarbons:

1. Benzine (petroleum naphtha). The commonly used benzine fraction in lacquers is the so-called "light oil." This substance is not considered to be toxic unless the concentration in the air exceeds 1,000 p.p.m.

2. Benzol. This is one of the most toxic of all the lacquer constituents. Concentrations in the air of 100 p.p.m. have been known to produce serious damage to the blood forming organs of humans.

3. Toluol and xylol. These are less dangerous than benzol because they are less volatile. However, air concentrations of greater than 100 p.p.m. may result in damage similar to that produced by benzol.

4. Solvent naphtha. This is a mixture of xylol, toluol, benzol and possibly some of the higher aromatic compounds. Various grades are used in lacquers. The toxicity is that of its component parts.

B. Alcohols:

Here we must consider the well known methyl, ethyl, propyl, butyl and amyl alcohols and the less familiar cyclohexanol and methyl cyclohexanol. Methyl alcohol is generally believed to be toxic in concentrations in excess of 100 p.p.m. Its outstanding action is on the optic nerve, causing blindness. Butyl alcohol in concentrations of 100 p.p.m. has caused damage to the blood, liver and kidneys of experimental animals. The other alcohols are probably not very toxic in ordinary usage. Practically nothing is known as to the possible effects of the cyclohexanols.

III. Plasticisers (softeners)

A. Oils. Castor, linseed and tung oils are commonly used in lacquers. These substances do not readily volatilize and hence may be disregarded as a source of danger in lacquer fumes.

B. Triphenyl and tricresyl phosphate. The latter is much more commonly used than the former. Both have boiling points over 400C and do not readily produce vapors. They are therefore not serious sources of danger in lacquer fumes. (Orthotricresyl phosphate was the cause of an outbreak of ginger-jake paralysis several years ago when it was used as an ingredient of a ginger extract and taken by mouth.)

C. Organic acid esters. In this category lie the methyl, ethyl and butyl esters of phthalic acid, amyl salicylate, benzyl acetate, benzyl benzoate, dibutyl tartrate and butyl stearate. Little is known of the toxicity of these substances, but since they are not very volatile they probably constitute a minor hazard in lacquer fumes.

D. Sulpho-compounds. These are either alkyl or aryl sulphones or sulphonic acid esters. Included in this group of plasticisers are amyl benzenesulphonate, amyl toluensulphonate, phenyl xylenesulphonate and p-toluene sulphanilide. Practically nothing is known of the toxicity of these compounds.

E. Anilides. These are not frequently used and little is known of their toxicity.

IV. Gums and Resins

A. Natural resins. Shellac, dammar, mastic, elemi and the copals are among the most commonly used natural resins. Shellac is said to have some effect on the blood, but as hazards in lacquer fumes these resins are probably of no significance due to their low volatility.

B. Synthetic resins. Among these are resin esters, cumaroneindene resins and phenolic condensation resins. None of these is of importance in the toxicity of lacquer fumes. Glyptal resins have recently come into some prominence, but nothing is known of their possible toxicity.

V. Pigments and Dyes

A. White Pigments:

1. Metallic. This group includes zinc oxide, lithopone (zinc sulphide and barium sulphate), titanium oxide, antimony oxide and barium sulphate (barytes). Antimony and barium are known to have toxic effects but

the concentration in respired air necessary to produce harm is not known and undoubtedly varies with the individual.

2. Nonmetallic. This group includes whiting (calcium carbonate), silicon dioxide and talc (asbestine). The last two can produce serious damage to the lungs, especially silicon dioxide which is the causative agent in the well known disease silicosis.

B. Black pigments. The most commonly used black pigments are: Bone black, ivory black, lamp black, carbon black, graphite and nigrosine. All except the last mentioned are essentially carbon and therefore inert. Nigrosine is an aniline derivative and is potentially toxic.

C. Blue pigments. Prussian blue, Chinese blue, bronze blue, and milori blue are all ferrocyanides. Ultramarine blue is a sulphur derivative of sodium aluminum silicate. None of these pigments constitutes a health hazard in lacquer fumes.

D. Red pigments. (1) Iron oxides. Turkey, Indian and Venetian reds belong in this category. They are non-toxic. (2) Synthetic red pigments (lakes), paranitraniline red, lithol red and toluidine red may be mentioned here. Being aniline derivatives they share the toxicity of this group of substances.

E. Brown pigments. Umber and burnt umber contain manganese and iron. Manganese is known to produce degenerative changes in the central nervous system.

F. Yellow pigments. (1) Ochre is a yellow oxide of iron and is non-toxic. (2) Chrome yellows. These pigments are essentially lead chromates. The deleterious effects of lead upon the body are well known. (3) Cadmium yellow. This is cadmium sulphide. There is reason to believe that cadmium may be toxic. (4) Zinc chromate. Probably not toxic.

G. Green pigments. (1) Chrome green is made from chrome yellow and consequently contains lead. (2) Chromium oxide green is non-toxic. (3) Copper carbonate is non-toxic.

H. Bronze powders. These are made from copper, zinc and aluminum and are non-toxic.

VI. Nitrocellulose

This compound is prepared by treating cotton or some other form of cellulose with nitric acid. The cellulose combines with the nitro radical of the nitric acid and forms nitrate compounds of cellulose, known as nitrocellulose.

Several types of nitrocellulose compounds are now prepared for use in lacquers. They vary as to solubility, viscosity and nitrogen contents and are used for the coating of different kinds of materials. As a health hazard, nitrocellulose is of no significance.

General Toxicity

For all practical purposes it may be said that the toxicity of lacquers depends upon the evaporation of the volatile fraction, which normally comprises about 75% by weight of the lacquer. (The toxic pigments are summarized below.) Frequently the amount of volatile matter in the lacquer is further increased before application by the addition of other solvents and diluents, practically of the same nature (called "thinners" in the trade). These thinners are commonly added in proportion of one, two or three parts of thinner to one part of lacquer. This results in an increase of volatile constituents from 75% to 87%, 91% or 93%, depending on the proportion of thinner added.

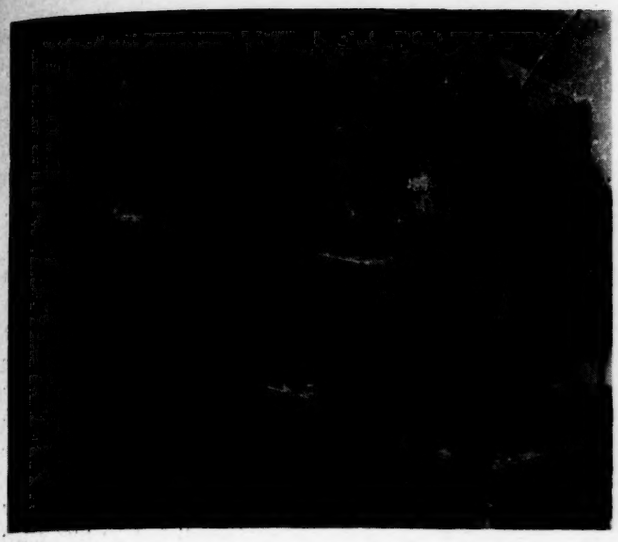
Since the most important route of absorption of volatile substances is through the lungs it is obviously important to keep at a minimum the concentration of vapors in the atmosphere. Even though some of the vapors may have no specific toxic action, it must be remembered that any volatile material will produce narcosis or asphyxia if present in sufficiently high concentrations. Absorption through the skin also takes place, so the practice of some lacquer workers of indiscriminately using solvents to wash their hands should be discouraged.

Among the pigments which may be toxic we have only to consider those yellows, greens and oranges which contain lead chromate, the aniline derivatives and possibly those containing cadmium, antimony and barium. Protective measures designed to control the hazards due to volatile material will automatically eliminate any possible danger from toxic pigments.

Fire Hazard from Lacquer Fumes

As is the case with health hazards, the principal fire hazard from lacquer fumes is due to the volatile materials present, although nitrocellulose adds another inflammable element. Practically all of the solvents and diluents in present day use are highly inflammable and, due to their high vapor pressure, are readily volatile. Therefore, when the lacquer is applied by either dipping or spraying, forming a thin coating spread over a wide area, these volatile materials evaporate very quickly. The lacquer coating is usually dry in about 30 minutes after being applied.

Automobile spray booth. Note lower baffles swing open to show fans. This illustrates the tunnel type of spray booth.



Cabinet type booth here used for spraying doll heads. Note baffles provided to prevent rebound of paint out of booth.

In addition to being highly volatile, lacquer vapors are about three times heavier than air and tend to settle near the floor, especially in the corners of the workroom where air may not circulate. This may result in the formation of concentrated pockets containing explosive mixtures. The flash point (or temperature at which a spark or flame will ignite these vapors) is much below the ordinary room temperature and an explosion will result if these vapors in sufficient concentration are ignited.

Methods of Control

Adequate ventilation is the most effective means of control of both the fire and health hazards. That is to say, if the fumes are removed with sufficient rapidity the hazards are reduced. *Hose or pressure type masks,* although protecting the worker against injurious vapors and dusts, *should not be used in lieu of proper ventilation* but may be required in addition to ventilation. Such masks are uncomfortable to wear and afford no protection against the fire hazard. Since suitable protection can be accomplished with less hardship, the employer will find it advisable to provide proper ventilation and so give the worker the benefit of the more agreeable working conditions. A ventilating system to be effective should remove the polluted air and also provide for an equivalent quantity of fresh air. The above condition is obtained by a properly designed mechanical ventilating system, the general design of which depends primarily on the type of equipment being used, whether dip tank or spray gun. For example, the ventilation necessary for removing vapors in dip tank operations may be obtained by general mechanical exhaust ventilation, in which the air of the workroom is changed approximately 12 times per hour; or by a lateral exhaust system located slightly above the surface of the liquid in the tank in conjunction with a mechanical exhaust drying alley; or a combination of both systems may be necessary. The decision as to the proper system to use must be governed by the amount and nature of the fumes released.

Ventilation for spray coating work has become much better standardized by the use of properly designed spray booths or rooms equipped with exhaust fans and ducts of proper capacity, by which a distributed minimum air velocity of 100 f.p.m. is generally provided over the face of the enclosure with a higher velocity provided when highly toxic materials like benzol and lead are employed. The use of spray booths has met with widespread favor. They accomplish four essential requirements: (1) The efficient removal of vapors and dusts by a positive air current; (2) the protection against health and fire hazards by preventing the release of injurious and dangerous vapors and dusts into the air of the general workroom; (3) by limiting the space to be ventilated, thereby saving on power, and (4) by acting as an aid to shop cleanliness.

Three chief types of spray booths are used for this work: The cabinet booth, canopy booth, and tunnel booth. They differ in design in order the more satisfactorily to meet variations in operating conditions, and, in particular, the size must be carefully determined to fit the work being done.

Coscos Tatti—The Last Word in Indian Air Conditioning

COSCOS TATTI may not be protected under any American patents, but they have been the means of bringing to the sultry gentry of India for ages past a form of air conditioning that is effectual, though primitive, according to J. A. Dooley, manager of the refrigeration department of the International General Electric Co. (India) Ltd., Bombay. The instruments of comfort bearing this strange name are window screens of woven grasses over which water is sloshed at regular intervals. They provide cooling and an additional refinement which is lacking in modern air conditioning —they add a delicate fragrance to the air. As the water evaporates from the screens it cools the air and releases the scent of the grasses, which, says Mr. Dooley, is like the sweet smell of the earth after an early summer rain.

Prevailing winds and breezes take the place of fans in providing ventilation and sufficient air for evaporation, and consequently only rooms on the windward side of the house can be cooled. Furthermore, the atmosphere must be dry if there is to be sufficient evaporation for cooling, and the system will not work therefore in the hot moist cities. Mr. Dooley cites the case of one Punjab official who is a difficult prospect because he gets 12 degrees of cooling from his grass screens by using a fan for forced draft.

In older times slaves were accustomed to pour buckets of water on the screens, but this has given way to an automatic system, consisting of a trough at the top of the screen. Water runs slowly into the trough, and when it is filled to a given point, it becomes overbalanced and dumps its load over the screen. Counterweights bring the trough back to its original position ready to be filled.

Fan Laws and Outlaws

By R. W. SMITH and T. C. LLOYD†

The laws of fan performance are simple but their correct interpretation is not always a simple matter. Neither are these laws always understandable because of the way they are stated. Here is a simple statement and some easy-to-understand illustrations of how to judge when a fan is reasonably rated.

THE purchaser of most manufactured articles has a fairly well defined opinion concerning what can be expected in the matter of performance and quality of the products he buys. This holds for many items—from automobiles to electric motors. If a salesman of either of the above articles should make claims of performance and efficiency too greatly in excess of those claimed by his competitors, the prospective customer might readily become suspicious as to the validity of the claims. He might reasonably suspect undue exaggeration with deceptive intent, or merely dumbness on the part of the salesman.

Yet the purchaser of a fan customarily has no yardstick by which to measure the performance, efficiency, and horsepower requirements of air handling equipment. This is undoubtedly due to the fact that there is but a small amount of reliable and authentic information available to the general public in a form that can be readily used. To the layman, fan laws are complex, and laborious and confusing calculations seem necessary to their use.

Due to this lack of knowledge on the part of the buyer and also due to the lack of proper testing facilities on the part of some manufacturers, it has become common practice with some of the less reputable makers to rate their fans by guess or estimate. To achieve ratings equal to or better than their competition, these estimates apparently err on the high side, resulting occasionally in an absurd overrating.

The fundamental relationship governing horsepower required to move air will be shown here. By means of such a relationship it is comparatively easy to determine the air delivery of a fan for a certain horsepower and diameter. If at the start we base such figures on 100% fan efficiency, then we will have at once the upper limit of what could be expected from a given fan. Since no fan is 100% efficient, all performance obtained in practice will be reduced from such figures by an amount which will be shown.

Moving air, by virtue of its motion, contains a certain amount of kinetic energy. This is the source of power for windmills and sailboats. Thus, if we have an open window into which the wind blows with a certain velocity, the power represented by this entering air is what is known as "air horsepower."

Consider that a fan is placed in this window under the following conditions: The fan area equals that of the window opening; the fan supplies the same amount of air per minute which the wind did previously when it was blowing. Then: The air horsepower in the two cases will be the same; the fan would be 100% efficient if the power driving the fan equalled the air horsepower of the moving air.

A series of curves is shown in Fig. 1 indicating the air horsepower, or the horsepower required to drive fans of 100 percent efficiency. These are based on standard horsepower ratings and are the results which would be obtained if ideal fans were tested in strict compliance with the accepted test code at standard air conditions. Although it is naturally impossible for any fan to reach such an efficiency, the curves are of value as a criterion by which published ratings may be measured.

Numerical results are obtained for such curves by the consideration that the power required to move the air is equal to the weight of air in pounds per minute, times the pressure head in feet of air, divided by 33,000. The latter constant comes from the fact that 1 hp. is equivalent to 33,000 ft.-lb. of work per minute.

Or, more conveniently, air horsepower:

$$\frac{\text{Volume of air, c.f.m.} \times \text{Total pressure in inches of water.}}{6356}$$

When a fan is discharging freely into the atmosphere, no appreciable static pressure exists, and as the total pressure equals the velocity pressure plus the static pressure, the total pressure will therefore reduce to velocity pressure only. This is measured as the pressure required to support a given column of water and is equal to $\left(\frac{\text{velocity}}{4005}\right)^2$. Tying together these relation-

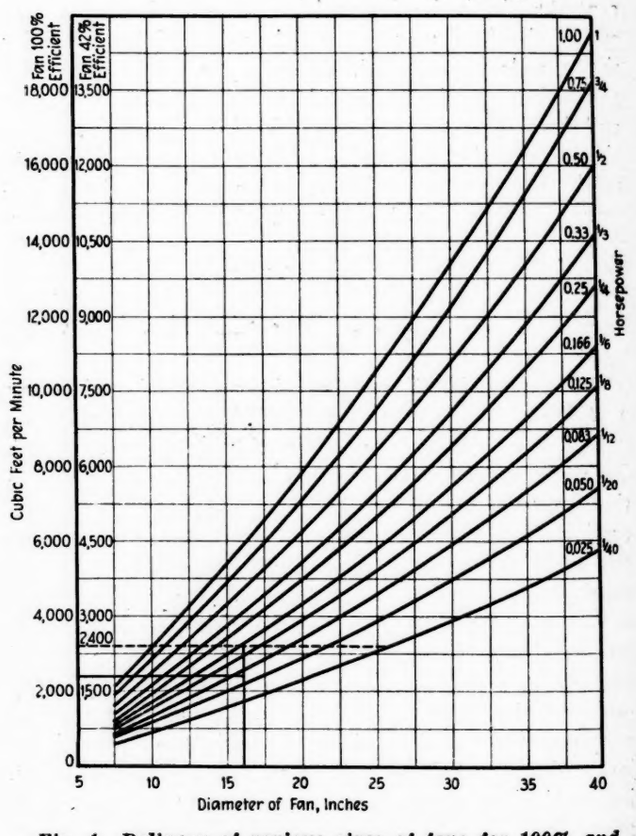


Fig. 1. Delivery of various sizes of fans for 100% and 42% efficiencies.

†Robbins and Myers, Inc.

ships results in the formula for air horsepower given, assuming also standard barometric pressure and temperature. These standards imply 68F at 50% relative humidity, density of air as 0.07488 lb. per cu. ft., and 29.92 in. of mercury as barometric pressure. It is from these relationships that the 100% efficiency curves are drawn.

In practice, most well designed fans have an efficiency at free discharge of between 30 and 50%, and for a good average, say 42%. The value of 42% efficiency can be used by a prospective fan purchaser as a fair figure to determine the quantity of air for a given horsepower or the horsepower required for a given air delivery. Any fan that is rated at more than 50% efficiency, under free discharge conditions, is probably overrated.

Strangely enough, the fact that a fan is 50% efficient does not imply that its delivery is only 50% of that which it would be for a perfect fan. Instead a 50% efficient fan delivers 79.4% of its perfect capacity; 42% efficiency implies 75% capacity, and so on. This relationship is shown on the curve of Fig. 2 and arises from the fact that the percentage delivery for any fan efficiency depends upon the cube root of the efficiency. That is, the efficiency expresses the ratio of the power necessary to move the air as compared to the actual power input to the fan; in the case of free discharge this varies as the square root of the velocity pressure cubed. The capacity, on the other hand, varies directly with the velocity of the air, or as the square root of the velocity pressure. Therefore, the numerical value of the ratio of actual capacity to perfect fan capacity is equal to the cube root of the fan efficiency expressed as a decimal.

For convenience a second scale is shown at the left of the curves of Fig. 1 indicating the effect of 42% fan efficiency. By reading this scale with the curves one may obtain the free air delivery for fans of various diameters, driven by various horsepower motors of standard rating. This scale is 75% of that for perfect fans and indicates about what should be expected of usual fan design.

As an example of the use of these curves suppose a 16-in. fan of 42% efficiency was required to deliver 2400 c.f.m. under free air conditions. Projecting up from the 16 in. diameter point to the 2400 c.f.m. intersection, it will be noted that this intersects the 1/6 hp. line.

If instead, the fan were 50% efficient, to supply 2400 c.f.m., read the intersection of the 16 in. diameter line, with the 2400 c.f.m. line using the 100% efficiency scale for the latter. This point falls between the 1/20 and 1/12 hp. curves and can be read as 0.07 hp. Then from Fig. 2 at 50% efficiency, the delivery would be 79.4% of perfect capacity, or the horsepower for the capacity given (2400 c.f.m.) would be 0.07 ÷ 0.794 or 0.088 hp. This is the correct horsepower required for this 50% efficient fan, but thinking in terms of standard ratings it would mean overloading a 1/12 hp. motor, or underloading a 1/10 or 1/8 hp. motor.

Some attention should be given to the matter of fan diameter. Note on Fig. 1 the dotted line drawn from the 2400 c.f.m. point on the 42% efficiency scale. It intersects the 1/40 hp. line at 26 in. blade diameter indicating that such a blade would require slightly

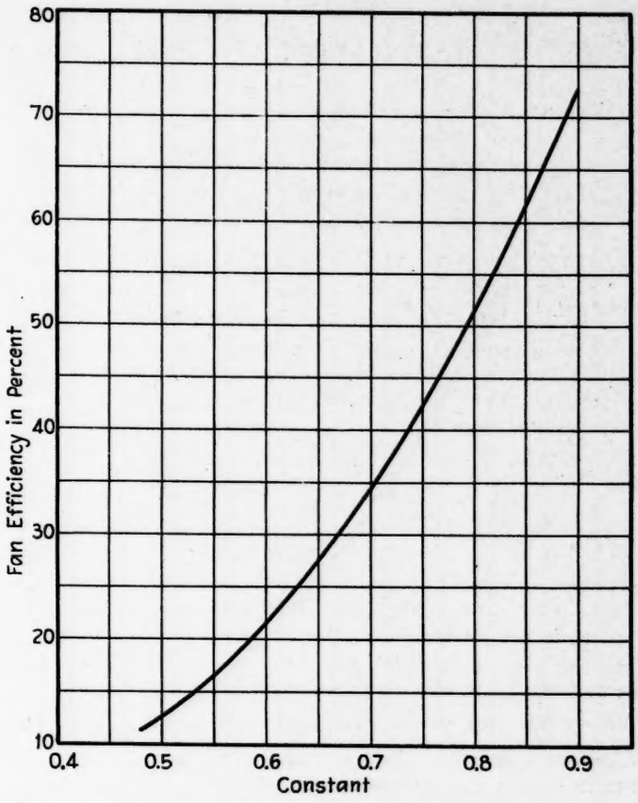


Fig. 2. Constant for determining effect of fan efficiency on delivery or horsepower.

less than 1/40 hp. On the other hand, to obtain the same air delivery, slightly over 1 hp. would be required if the blade were only 10 in. in diameter. This change of approximately 40 to 1 in horsepower by changing fan size from 26 to 10 in. is not at all unusual.

Assume that the efficiency of a 1/40 hp. motor were 25%. The watts input would be 74.6. With an efficiency of 75% for the 1 hp. motor, its input would be 995 watts. To deliver the same air, 13.3 times the power is required by the smaller fan (rounding off the figures to commercial horsepower sizes) yet each is 42% efficient. This indicates that the rating of fans by efficiency alone does not give the complete story; instead some such term as "fan economy" is more indicative of what the user will obtain for his money. This could be defined as the cubic feet per minute divided by the watts.

Now in the case of the 26 in. fan, 2400 divided by 74.6 watts or 32.2 c.f.m. per watt, represents the fan economy. For the 10 in. fan, 2400 divided by 995 or 2.4 c.f.m. per watt represents its economy. This is a greatly different impression than is gained from the mere statement that each fan is 42% efficient, and always favors large diameters.

Although larger diameter fans result in lower air velocity, lower tip speed and hence less noise, they offer the disadvantage of higher first cost. It is also true that on some installations smaller diameter fans are required for mechanical space limitations. Then too they give increased air velocities which are important for "penetration" on circulators or drying installations. Exhaust systems carrying dust or similar particles require high air velocities to insure continued movement of the particles.

In addition to the data just given on efficiencies, a few of the simpler and more easily applied fan laws are:

For a given fan size and varying speed—

(1) the capacity varies directly as the speed ratio, (2) the static pressure varies as the square of the speed ratio, (3) the power varies as the cube of the speed ratio.

Thus as an example suppose we have a fan delivering 5000 c.f.m. at 1 in. static pressure and requiring ¼ hp. If the previous speed is 875 r.p.m. an increase in speed to 1750 r.p.m. would result in the following changes.

Since the capacity varies as the speed ratio (1):

The capacity would be $\frac{1750}{875} \times 5000$ or 10,000 c.f.m.

Since the static pressure varies according to (2):

The static pressure would be $\left(\frac{1750}{875}\right)^2 \times 1$ or 4 in.

Since the power varies as stated in (3):

The horsepower would be $\left(\frac{1750}{875}\right)^3 \times \frac{1}{4}$ or 2 hp.

In the long run any industry profits most by supplying its most effective and efficient product for its market. In the case of fans, comparatively few simple curves and rules are necessary to check the efficacy of any setup. But those rules must be correctly and honestly applied.

School Heating in Norway

SOME time ago the board of the Oslo, Norway, municipal power works, acting on the advice of its technical director, decided to experiment in large-scale electric heating, reports Svend Anker-Rasmussen in a recent issue of "The Electrical Review." Among the schemes was one at the Foss school. The total floor area of the main building, which is of three stories with a large basement and attic, is 49,600 sq. ft. and the volume 628,000 cu. ft. The installation totals 251.85 kw.

The new heating system was tried out for the first time in March, 1936, though the installation was not quite completed until the beginning of July. The consumption of power amounted to 86,400 kw-hr. in March and 30,900 kw-hr. in April, the average temperature of the months in Oslo being 33F and 40.2F, respectively. The system during these two months was chiefly operated by hand regulation, but a special automatic heat control system has now been installed and the consumption is estimated to aggregate 300,000 kw-hr. for a whole heating season.

The installation in the classrooms comprises low-temperature panel heaters under the windows and high-temperature (glowing) heaters near the ceiling. The panel type are to compensate for the building's heat losses, while the others are switched on between lessons. The electric heaters deliver the major part of their effect in radiant heat and the smaller part by convection. The advantage of this arrangement is that a lower temperature can be maintained.

The daily variations of temperature in the classrooms are controlled by a "feeler" that reacts equally well to radiant heat and convection. It consists of a closed receptacle filled with a volatile fluid. By means of a little resistance heater under the receptacle the latter is kept always at about 75F. Variations of the conditions in the room alters the pressure of the vapor in the receptacle. This affects a pile of carbon discs, resulting in variations of the ohmic series resistance over the discs. The resistance is coupled to a motor, the rotation speed of which thus varies according to the variations of resistance. By means of a stage-switch these impulses are then transmitted to the main switchboard from which the installation is partially switched on and off according to the demand. The installation in each classroom is divided into four stages, one for each half of the radiators and convectors. The power is thus never switched on or off instantaneously, the order being first one half of the convectors, then one half of the radiators, and then the remainder in the same order.

In addition the Foss system includes "impulse" switching arrangement that governs the time when the heat is to be switched on in the morning and off at noon-time. This device consists of a switch arrangement operated by clockwork. A number of metal rings are fastened on a cylinder in such a way that they form the cooling-off curve characteristic of the building. By the rotation of the cylinder this arrangement of rings is brought into contact with a set of springs giving impulses to a governor-relay which operates the stage-switchgear. A metal wing for the closing down of the whole plant is also mounted on the cylinder. The wing can be fixed as wanted and gives, via a set of contact springs on the rear side of the cylinder, the necessary "out" impulse to the governor-relay. The construction of the cylinder is such that the curve form can easily be adapted to the characteristics of any other building. On the left side of the "impulse" switch is mounted an extremely sensitive thermo-regulator. In case of temperature variations in the room, contractions or expansions occur in the regulator and these are mechanically transmitted to wheels in front of the device. Between the wheels is mounted a cord which is fastened to the set of contact springs. This set is thus subjected to horizontal movements which cause the whole plant to be switched on earlier or later than normally.

When the school is not in use the whole heating plant is automatically closed down, as the time-switch of the automatic switching apparatus will have given its "off" impulse to the governor-relay. In case of weather conditions changing during the winter, the heat is not switched on before it is absolutely necessary, the correct time being indicated by the thermo-regulator. If temperature changes take place during day hours, the "feeler" together with the stage-switch ensure that only the strictly necessary amount of power is switched on at any time. Overheating is thus effectively avoided.

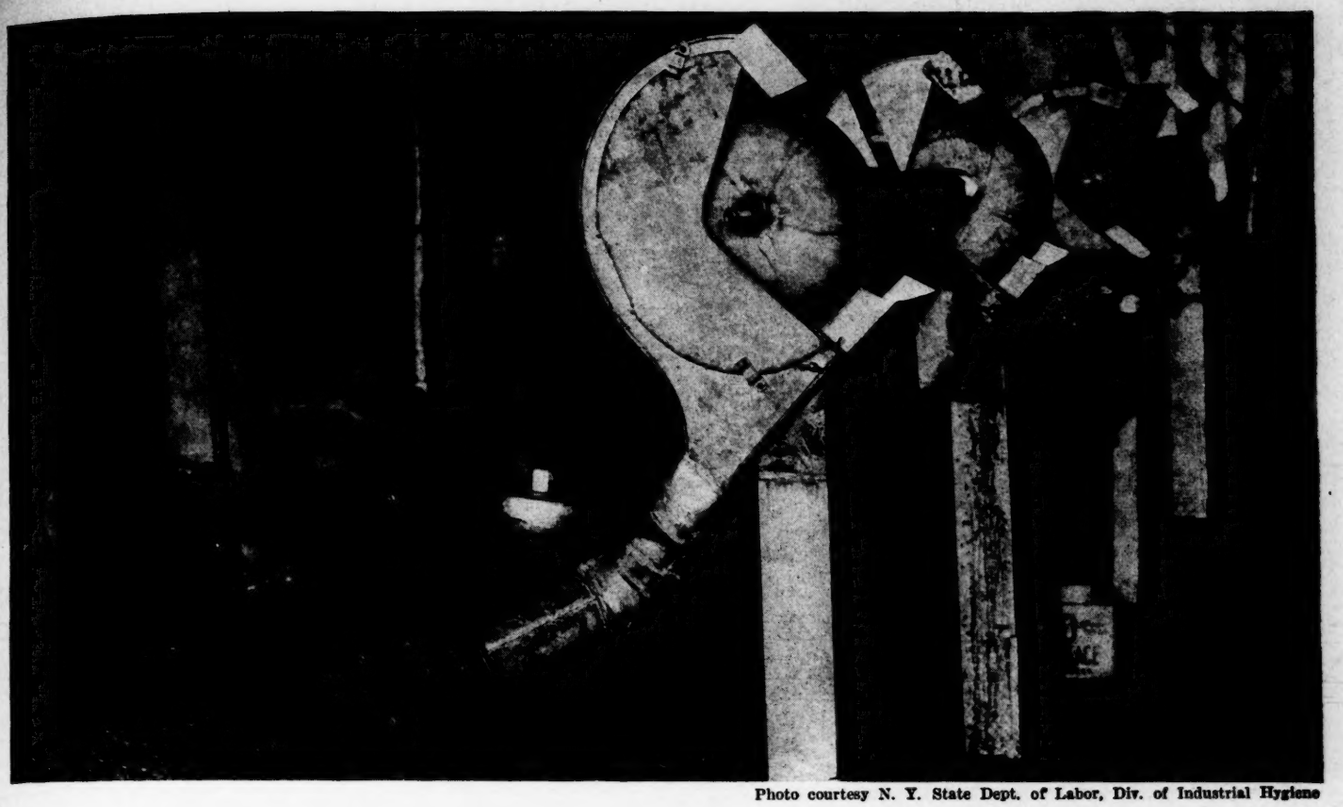


Photo courtesy N. Y. State Dept. of Labor, Div. of Industrial Hygiene

Harmful Organic Dusts in Industry

Dust in the air is one of the problems now attracting much attention, especially the dusts encountered in industry. The author, Dr. R. R. Sayers, Division of Industrial Hygiene of the National Institute of Health, outlined the characteristics of the harmful industrial dusts, both organic and inorganic, in a paper before the National Safety Congress recently. In this abstract only the organic dusts are discussed but in a later issue the subject will be extended by including a similar description of inorganic dusts and how dust control in industry is achieved.

WHILE dusts exist everywhere in the atmosphere, it has been recognized for centuries that workers in certain dusty occupations are less healthy than those not so exposed. The number of persons exposed in dusty occupations comprises one of the largest industrial groups. The occupational diseases of workers in dusty atmospheres have been found to be due to entrance of dust into the system by inhalation, by ingestion, by direct absorption through the skin, by irritation of the skin, or by a combination of the foregoing.

Sollmann, after analysis of various definitions for poison, felt that it was very difficult to give a definition which would not be ambiguous in some cases, but believed that the following covered most of the points which must be considered in classifying a substance as such:

> **A poison is any substance which, acting directly through its inherent chemic properties, and by its ordinary action, is capable of destroying life, or of seriously endangering health, when it is applied to the body, externally, or in moderate doses (to 50 gm) internally.**

Some dusts are known to be poisonous, while others, in the concentrations usually encountered, are comparatively harmless. However, it may be stated that *breathing* dust in high concentration is not desirable.

According to Drinker, there are four different types of reaction produced in man by the inhalation of dust. The first and most important are the pneumoconioses, such as silicosis and asbestosis, which cause specific lung pathology and often are followed by pulmonary tuberculosis. The second type of reaction is caused by toxic dusts, like lead, cadmium, and radium. A third type of malady follows the inhalation of finely divided metallic fume particles, such as zinc oxide, and is known as metal fume fever. The fourth reaction, allergic in character, is caused by breathing organic dusts, such as pollen and certain types of pulverized wood and flour. In all four cases the sole cause of the disability may be dust inhalation, but the reactions from toxic dusts result from swallowing as well as from inhalation.

For various reasons it is difficult to set up an absolute classification for dusts. Opinion is rapidly changing regarding so-called inert or harmless dusts and further investigation may prove some of them to be

injurious. Some dusts may have both a toxic and an irritant action; while, on the other hand, the poisoning resulting from exposure to a dust may be the combined effect of more than one mode of entrance into the body. However, the following classification of dusts, according to physical characteristics and physiological effect, is used for convenience.

Organic Dusts

Organic dusts are those which contain carbon, and were originally supposed to come from organized substances derived from animal or plant life. Living dusts come under this classification and are thought to be of the same order of size as industrial dusts, with which they are frequently associated. Bacteria are usually between 0.5 and 3 microns, except in a few cases, such as the anthrax bacillus, which ranges from 1 to 1.25 micron in breadth and 4.5 to 10 microns in length. Spores of fungi may range in size from less than 1 micron to 20 microns in length and up to 12 microns in diameter. However, it is possible that the larger and heavier varieties, like the larger and heavier dust particles, settle by gravity, and do not remain suspended in the air.

Many thousands of organic substances, carbon-containing, are made synthetically by chemical processes, such as dyestuffs, explosives, and similar substances.

Non-Living Organic Dusts

As the name implies, these are composed of nonviable particles, which may or may not be inherently toxic or irritant, but which nevertheless produce untoward effects in the human organism. "Allergic" dusts, or those to which only certain persons are or may become hypersensitive, with resulting asthma, rhinitis, or other disturbances, are included in this classification.

(a) Toxic and (or) irritant dusts.—Toxic or irritant dusts are all organic dusts which produce untoward symptoms, either systemic or local. Those producing local symptoms are usually described as irritant; those producing general or systemic symptoms are termed toxic. A dust may be both toxic and irritant.

In reported cases of injury or death following inhalation of dust from organic compounds, among the chief offenders are paranitraniline, the dinitrobenzenes, chlorodinitrobenzenes, trinitrophenol, and nitronaphthalene. Eye damage due to inflammation of the cornea has occurred among workers exposed to methyl violet dust. The dust from paraphenylene diamine derivatives is particularly irritating and dangerous, causing not only a severe form of dermatitis where the dust comes in contact with the skin, but also producing acute inflammation of the mucous membrane of the respiratory passages. Toxic dusts may be generated during the handling of powdered dyes and in preliminary dyeing operations, particularly the hydro-extractor process, where particles are disseminated in all directions. Coal tar and indigo dyes are substances frequently used.

Cases of amblyopia have been reported from exposure to inhalation of tobacco dust. It has been found that inhaled tobacco dust exerts a nicotine action on the organism 15 times greater than that produced by the same quantity of smoked tobacco with an equal nicotine content.

Severe dermatitis is experienced by many workers handling powder containing TNT, which is used in making high explosives. Picric acid, which is also used for this purpose, requires drying, and in this latter state it has been found to produce a dermatitis. Picric acid is also the oldest synthetic organic dyestuff. Dermatitis occurs among handlers of silk with varying frequency. Salls determined that a rash occurring among workers in a silk factory was due to dust from silk cocoons imported from Africa.

Persons engaged in the manufacture of quinine and quinine preparations suffer from skin phenomena, which occur for the most part on exposed parts of the body, and may be caused by ingestion or by quinine dust, or powder form of the preparation, exerting a direct irritating effect on the skin. Dermatitis due to other vegetable dusts such as vanilla, powdered arnica, pyrethrum, etc., has been reported.

Dental lesions, of occupational origin, have been reported among workers in sugar. The gingivitis caused by sugar dust is classified as purely mechanical, with later-developing caries. Digestive disorders, respiratory conditions, and cutaneous conditions (especially of the face) have also been reported.

Dock workers, transporters of grain, workers in grain and flour mills, and persons in similar occupations are exposed to dusts during their work. Dusts from cereals may contain many impurities, which may cause an irritating action on the respiratory passages, as well as inflammation of the skin. Digestive disturbances, dental defects, diminution in hearing, and conjunctivitis have been observed among millers, and have been attributed to the dusts to which such workers are exposed.

(b) Allergic.—Many apparently innocuous substances may produce reaction in persons of peculiar personal susceptibility. The term "allergy" is used to describe this condition of hypersensitiveness, or susceptibility, and allergic phenomena most frequently manifest themselves in skin reactions. However, they may cause acute reactions elsewhere in the body. When the respiratory tract is involved we have such well-known diseases as hay fever or asthma. These diseases may develop as a result of hypersensitiveness to such substances as pollens from plants, horsehair, furs, feathers, and the like. For instance, furriers, workers in clothing industries who are exposed to wool dust, and others may suffer from hay fever or asthma. It is unnecessary for the offending dust to reach the depths of the lungs (giant pollens, for example, are reported to produce their effect after being caught in the upper respiratory passages). Should such an offending substance be finely ground, it could reach the alveoli and as a result probably all physiologic reactions would be accelerated.

In a survey of a plant where resin is mixed, ground, and molded, it was found that 80% of the occupational dermatitis there was due to hypersensitivity to hexamethylenetetramine and formaldehyde contained in the dust to which the workers were exposed. During the first processes of cotton spinning, cotton-strippers are exposed to dust arising from cotton husks and debris, which produces a typical form of asthma.

Ordinary wood dust has been of interest, owing to its purely mechanical action; but still greater care is re-

quired in handling certain kinds, especially woods coming from abroad, because of the essential oils impregnating them, which when freed in the dust may affect the health of the workers concerned. Some of the woods capable of causing skin lesions are Brazil wood, satinwood, teakwood, cumaru or tonka wood, black ebony wood, West Indian mahogany, Japanese tagayasan, coccoloba, chestnutwood, olivewood, and California sequoia (redwood). All persons who handle these woods are not injured, only those particularly susceptible to the substances they contain becoming affected.

Living Organic Dusts

Living organic dusts contain particles capable of exhibiting the phenomena of life (especially the property of reproduction or multiplication), such as bacteria and fungi. They are usually found in low concentrations and are associated with non-living dusts in the air.

(a) Bacteria.—One of the most important among these is the anthrax bacillus, which is contained in the dust from skins, furs, wool, and animal hair, horns, hoofs, bones, and similar animal products. This disease may occur in two forms; namely, *cutaneous* (in which the organism affects the skin) and *pulmonary* (when it is inhaled, as in the form of anthrax known as wool-sorters' disease).

Cases of tetanus reported in connection with jute manufacture were traced to the raw material, the bacillus having been found in the factory dust. Diphtheria, tuberculosis, smallpox, typhoid, and other bacillus-produced diseases, may result from exposure to infected dusts.

Bacterial sensitization can be the cause of any of the allergic diseases; namely, asthma, perennial hay fever, urticaria, angioneurotic edema, eczema, or migraine headaches.

(b) Fungi.—Dusts containing the mycelia and spores of parasitic fungi give rise to annoyance and discomfort. "Maltster's" itch from the dust alone has been reported. In Provence, reeds used for ceilings are stacked while still wet and undergo fermentation; they become covered with a white powder (a dry fungus of the Mucor family), which is scattered when the bark is stripped off. This powder is irritating to the skin and mucous membranes. Mycelia and spores of molds are commonly found to cause rashes; an example is the black powder coming from macerated surgarcane stalks. Among basket makers, the mycelium and spores, in the form of a white mold (hyphomycete) from the rattan canes used, get shaken out when the canes are split, hammered, and cut, causing painful fissures to develop on the skin where they alight.

A form of asthma or spasmodic cough, suffered by cotton weavers and known as aspergillosis, has been considered due to inhalation of spores of a mildew which sometimes occurs on the threads. In a study of silicosis among miners, made by the Public Health Service, a number of cases of typical miliary calcification were encountered. Unstained smears from those cases examined were positive for fungus, two types of Aspergillus fungi being identified. All of the subjects but one were farmers, teamsters, feedmill workers, or residents of small agricultural towns where grain is marketed. Farmers are exposed to fungi in threshing wheat, baling hay, or handling various small grains.

Some other fungus diseases, such as actinomycosis and blastomycosis, are associated with occupational exposure to dust. The former occurs among workers handling straw, hay, grass, vegetable debris contaminated with mold, and similar material. Actinomycosis is likely to affect people engaged in commercial handling, storing, and cleansing of grain (grain distilleries, flour mills, grain crushing, brewers, and malting houses, etc.).

Solar Heat Estimates from Surface Temperature Rise

ONE of the greatest uncertainties in assigning the proper outside temperature is the effect of sunshine. In calculations of heat flow there is at present no accepted, practical way in which the effect of sunshine can be estimated accurately. This effect depends upon the thickness of insulation, the latitude, the season, the orientation of the wall, the normal wind velocity over the wall, the color and nature of the surface, and other factors. To include all the factors in a formula which could be applied for practical use appears to be impossible. Certain arbitrary or empirical methods for estimating solar heat absorption have been used but with indifferent success. It appears that the most promising basis for these estimates would be experimental observations of the effect of sunshine on exposed surface temperatures rather than measurements of quantities of heat absorbed under various conditions. If the rise in surface temperature due to sunshine is known, the effect on heat flow inward can be calculated. Observations on refrigerator cars indicate that measurements of the effect of sunshine on temperatures of flat black surfaces can be generalized to cover the various latitudes, seasons and orientation of walls with a fair degree of accuracy for year-round averages. They further indicate that for surfaces other than flat black a fairly constant relation exists between the surface temperature of each color and that of black. For example, if the sunshine intensity and exposure are sufficient to cause a black surface to maintain a temperature 50F above air temperature, the surface of a certain light color may at the same time be only 25F above air temperature. If under other conditions the black is 20F warmer than the air the white will again be heated about half as much and will be 10F warmer than the air. This relation which appears to hold fairly well is of course complicated by heat capacity of the wall and other factors, but for practical use the establishment of approximate relationship between surfaces of various colors and reflective natures would assist in establishing a fairly accurate basis for calculating the effect of solar radiation on heat flow into insulated walls.—*From "Wall Construction for Air Conditioned Houses and for Refrigerated Storages," by W. V. Hukill, Division of Structures, Bureau of Agricultural Engineering presented before the North Atlantic Section of the American Society of Agricultural Engineers.*

Condensation Nuclei Are Air Hitch-Hikers, Research Shows

RESEARCH engineers have upset an earlier scientific opinion and exposed condensation nuclei as merely atmospheric hitch-hikers who ride in crowds in stale air, make themselves scarce in fresh air, but paradoxically do not affect the freshness of air.

This conclusion is reported by Dr. R. A. Nielsen of the Westinghouse Research Laboratories who conducted a five-month test in search of what makes fresh air fresh. For some time it has been thought possible that the nuclei content of the air is a determining factor in its freshness, but the researchers trapped billions of nuclei in a metal sealed room and in rubber balloons, saturated and expanded the air which carried them, and counted the resultant water droplets in an Aitken counter to convince themselves that the masses of condensation nuclei do not have any effect on air freshness or staleness.

Where do these nuclei, these mysterious factors in the air, come from, and what is their purpose? Science can answer the first half of the question but Doctor Nielsen is convinced that exact knowledge of their purpose will have to wait upon future research. Human bodies produce these particles in great numbers—millions a second; smoking sends them forth about 50 times faster than the body, and heat and cold both act as strong productive forces.

In mountain air the average number of condensation nuclei is a few hundred in each cubic centimeter. In cities the concentration of these invisible particles is much higher than in the country. Hence the thought that the presence or absence of the nuclei determines the freshness of air.

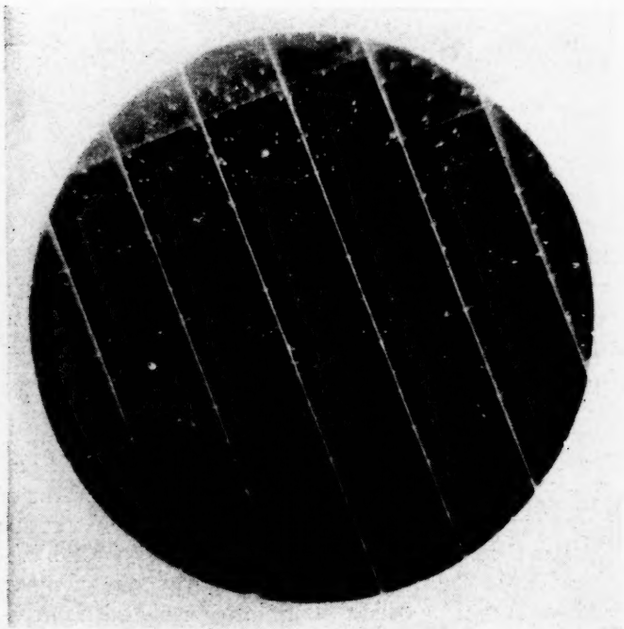
The research engineers set out to duplicate the nuclei content of mountain air. They built a 200-cu. ft. metal room and equipped it with air ducts. By recirculating the air through the ducts and filters, they reduced the nuclei content from 50,000 to only 700 per cubic centimeter. Because of slight air leakage the count rose to 1,000 within 90 min. after the recirculation was stopped, but even so the nuclei content inside the metal chamber was still comparable to that of mountain air.

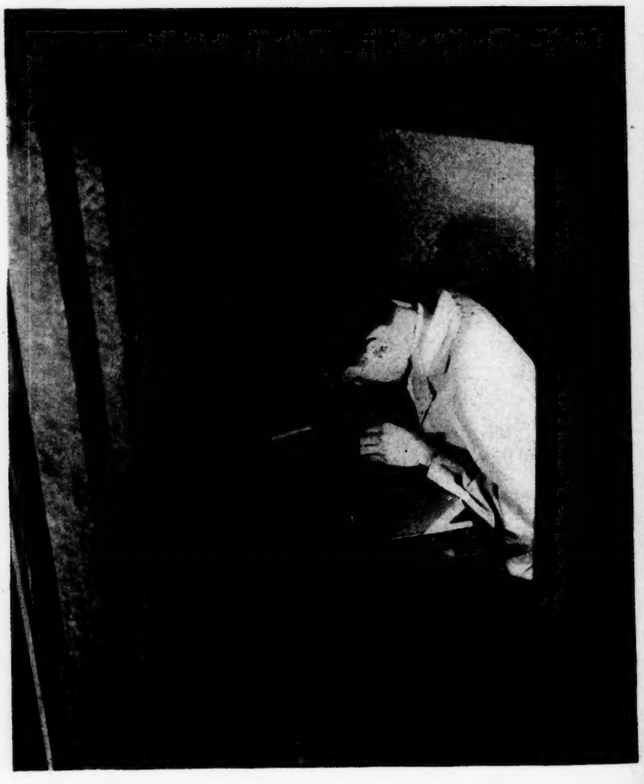
One of the investigators then entered the chamber. He closed the door quickly but not before another thousand nuclei had crowded into each cubic centimeter of air. Half an hour later the count had increased to 6,000 and then increased gradually to 7,000.

When the metal room with the low nuclei content was first entered no noticeable feeling of freshness was experienced. However, after an hour's occupancy of the metal room, the investigator felt a marked freshness upon returning to the laboratory room, where the nuclei count was many times higher.

Doctor Nielsen reported that the Aitken instrument indicated that air from the breath contained fewer nuclei than the inhaled air. When a balloon was distended by many short breaths there were more nuclei in it than when it was distended by the second half of a deep breath. Air sampled from the second half of the breath contained from 2,000 to 5,000 nuclei per cubic centimeter, while the inhaled air contained around 50,000.

However, the investigator ventured the opinion that some day it may be possible to separate the various groups of condensation nuclei produced by different sources and by that means discover that certain groups do affect the freshness of air.





(Above) Sprinkled like stardust, the white specks are water droplets formed by invisible condensation nuclei in the air. The ruled squares on the glass slide are only one millimeter long—.03937 of an inch. (Right) Dr. R. A. Nielsen in his metal-sealed laboratory, tabulating condensation nuclei in conditioned air.

Taking the Impurities Out of Air

By H. C. MURPHY†

The air cleaning problem as presented to engineers is complicated both by the range in size of the dust particle and by the diverse nature of the impurities to be removed. However, effective equipment to accomplish the cleaning is available. The author, well known through the industry, reviews the nature of the problem and describes the principal features of the present-day equipment. The article is abridged from the remarks made at the short course in air conditioning at Michigan State College in March, 1938

IT is difficult for the human mind to conceive the infinite varieties of dust. Every material in the universe enters into its composition, every form and shape is represented in the countless particles stretching from the surface of the earth to the upper regions of the air. However, the dust which the engineer is called upon to combat is capable of ready investigation. It ordinarily consists of soot and unconsumed carbons, pollens, tree dusts, sand, fibers, decayed animal and vegetable matter, bacteria and molds, varying in size from the objectionable "cinder" which is sometimes caught in the eye, to particles of almost inconceivable smallness.

Nature of Air Dusts

The Scotch investigator, Aitken, proved that some dust particles are so fine that they remain suspended in the air for two years and longer, passing several times around the earth and probably ascending to heights of 40 to 50 miles.

After volcanic eruptions the atmosphere often remains charged with dust particles thrown off for extended periods, giving rise to extraordinary sunsets and other remarkable chromatic phenomena. Cinders from the Chicago fire reached the Azores 40 days after the outbreak and science today explains the "Sulphur Rain," the "Yellow Day," and other awe-inspiring occurrences of earlier days, as well as the rapid spread of epidemics, as due to the dispersion of dust particles in the upper currents of the air. In the war time influenza epidemic, whole colonies in isolated islands and unfrequented localities which had no communication whatever with the outside world were wiped out, probably by such dust-borne infection.

Microscopic examination of a typical sample of dust from an industrial center shows:

	Per Cent
Smoke carbons (soot)	45 —47
Silicious matter	40 —43
Coal dust	2½— 3½
Fibrous	3 — 4½
Miscellaneous	6 — 8

†Vice-President, American Air Filter Co., Inc.

Air Pollution and Respiratory Diseases

Investigations in this country and abroad have shown a surprisingly close relationship between excessive pollution of city air and the abnormal prevalence of respiratory infections. In England, preliminary investigations have been made by the government meteorological office as to the relation of dirty air and health and an attempt has been made to correlate the amount of impurities in the air with the number of deaths in London. In Germany, investigations headed by Dr. Louis Ascher some years ago pointed to a definite connection between air pollution and abnormally high death rates from respiratory diseases.

The city of Akron, Ohio, has made an extended study of air pollution and its bearing on sickness among school children. Careful records of the dust concentration in each section or ward of the city were collected by the School Board over a period of two years, together with the number of school absentees and the total number of deaths. The results shown by the chart are of interest in this connection.

Medical science has within the last few years made remarkable progress in the treatment of certain disorders such as hay fever, bronchial asthma, and some of the other so-called allergic diseases by air filtration.

Dr. Siegfried Maurer, a Chicago physician, who has specialized in these so-called allergic disorders, made pollen counts in a number of public buildings in Chicago. In the Field Museum, which is equipped with air filtering apparatus, he found the count seldom exceeded the remarkably low figure of 10 granules of pollen per cubic yard of air, whereas on these days in certain other Chicago buildings the count was 10 to 20 times as many.

Doctor Maurer further states that the Museum's count was only about one-half of that found at several northern resorts to which hay fever sufferers go. He

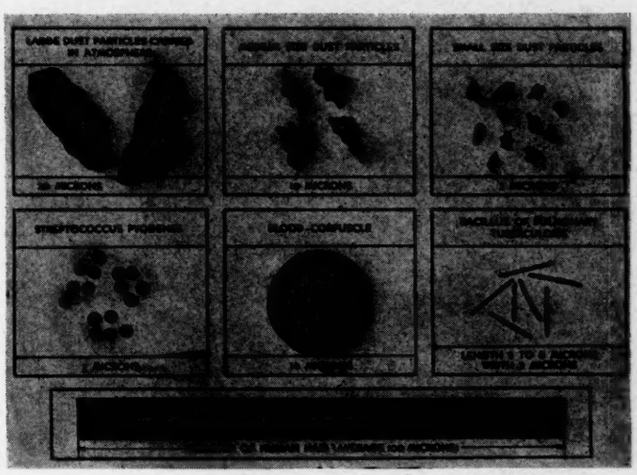


Fig. 1. How the sizes of typical atmospheric particles compare with the diameter of a human hair.

reports a total pollen count of 156 granules per cubic yard in 20 days in another large Chicago public building and 8445 in 37 days at an outdoor observation station. He states, "I would recommend the Museum as a safe place for hay fever sufferers to spend the day in order that they may be in an atmosphere relatively free of pollen and one in which most hay fever victims should become completely free of symptoms."

It is becoming more apparent that air impurities are a causative factor in many of our so-called common colds. The investigator, S. N. Key, has shown that persistent winter colds which occur every year in Texas are due to the pollens of the Mountain Cedar which are shed and wind-distributed in enormous quantities from mid-December to February. In the persistent winter colds as well as the summer cold which hangs on, we have learned to view with suspicion many heretofore unsuspected causes. Medical science has definitely shown that pollens from many well known trees may and do cause the condition variously called "early spring fever" and "tree hay-fever."

Bacteria in the Air

The number of dust particles and disease germs in the air has been investigated by numbers of careful investigators. Taking ten liters of air as a basis, in the Boston City Hospital, nearly 450 living bacteria and 225 mold spores were counted in a 5-min. exposure of standard agar plates. In a model New York hospital where every precaution for cleanliness was taken, 12 germs settled on the plates, and after agitating the air, over 266. In a typical New York apartment house, a 5-min. exposure gave a count of 75 and after sweeping the count rose to 2700.

Recent investigations in New York City by two separate groups of investigators indicated that theaters equipped with the ordinary viscous unit filters had a lower bacteria count than that in the public parks. The bacteria count in non-ventilated theaters was 8.4 bacteria per cubic foot of air. In the ventilated theaters equipped with air filters, the bacteria count was 1.4 bacteria per cubic foot of air. In public schools, which were not equipped with the ventilating systems or air filters, the bacteria count ran as high as 21.1 per cu. ft. of air.

Another survey by Drs. C. B. Coulter and F. M. Stone of the College of Physicians and Surgeons, extended over a period of 18 months and covered 246 telephone booths. They found approximately the same number of air-borne organisms in the un-air-conditioned telephone booths throughout the city. These organisms consisted of pneumococci, streptococci, and other common respiratory germs. They reported, however, that telephone booths in the R.C.A. building, equipped with viscous filters, had an average of 32 bacteria per cubic foot as compared to 500 bacteria per cubic foot in the Long Island Railroad station. The investigators attribute the difference to the filtered air in the telephone booths at Radio City.

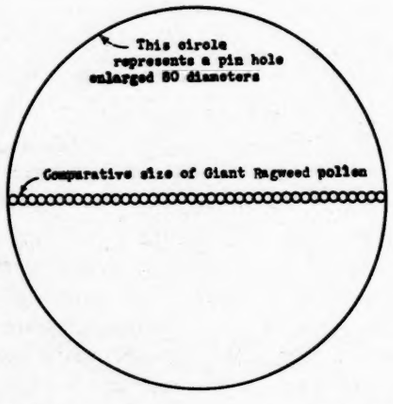


Fig. 2. Forty ragweed pollen particles could be laid across the diameter of a common pin hole.

The medical profession has taught that the ordinary germ carrying droplets are not significant in the transmission of respiratory diseases. The recent work of Wells and Stone at the Harvard School of Public Health, has shown this supposition to be false. The investigators at Harvard sprayed distilled water in a sterile microbe-tight chamber. Most of these droplets were of very minute size and they evaporated before they fell to the floor; however, samples of air taken from the chamber at intervals of from 30 min. to 8 days disclosed thriving colonies of bacteria. Investigators report that some bacteria were thus carried about alive for days, others died in less than an hour. The investigators report that bacteria expelled in the air and therefore easily inhaled live longer than those carried by liquids and foods and that microbes from the nose and throat live long enough in the air to transmit disease.

Dr. A. I. Kimball, Dean of the Northwestern University Medical School, demonstrated this same process a number of years ago and described it in his book "Civilization and the Microbe" which was published in 1923.

Viscous Impingement Filters

The desirability of pure air has long been realized and the steps in the development of apparatus for air cleaning have been interesting. The first air cleaner was undoubtedly the human nostril, in which the mucus coated hairs act on the viscous impingement principle and have a surprising efficiency in the removal of dusts.

Cloth or metal screens were used in industrial operations and for that matter are still used in this work. It was found, however, that when used dry they stopped the larger particles but allowed the smaller dust to go through. Ordinary commercial cement, for instance, is guaranteed by the manufacturer to have passed through 100-mesh screen. It is apparent that the 40-mesh screen which is ordinarily used for ventilation work would allow a large part of the dirt to pass through. If a screen fine enough to remove the small particles were used, or if the screen were oiled it soon clogged up and obstructed the air flow.

The advent of the air washer practically eliminated cloth screens from general ventilation work. Various types were developed and much ingenuity in design was shown, especially as regards the spray nozzles. The air washer was found to be relatively inefficient in the removal of soot, smoke, and similar carbons. These are light, greasy substances, insoluble in and

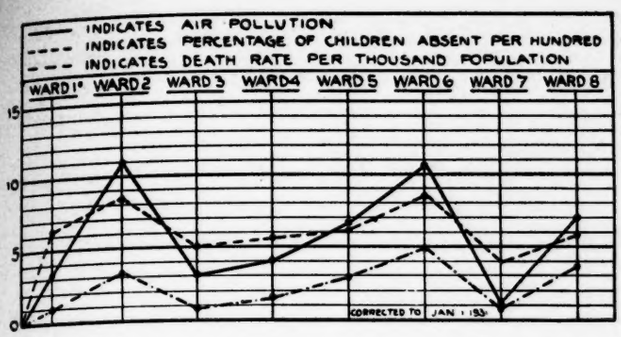


Fig. 3. Relation of air pollution, death rate and school absentees as reported from studies in Akron, Ohio.

almost totally unaffected by water. The greatly enlarged manufacturing activities of our city life and the advent of the automobile complicated the problem considerably and forced the consideration of other means of air cleaning.

Attention was again directed to air filters—so called. In reality, the modern viscous air filter does not filter the air at all. As the dirt and dust are taken from the air and collected on the adhesive coated surfaces, additional supplies of the binding liquid are continuously required in order to bind additional layers of dirt. This requirement is met in most unit viscous filters by the retention throughout the filter medium of oil droplets. These droplets are held at the innumerable crossings where the wires or strands comprising the filter body touch each other. However obtained, these additional reservoirs of the binding liquid perform a most important function, allowing the oil to spread by capillary action as fresh dirt is deposited upon the filter, and binding subsequent layers until the oil supply is exhausted.

In selecting charging liquids for viscous filters, particular attention should be paid to the characteristics of the filter and the recommendation of the manufacturer. It is obvious that a charging liquid that would be entirely satisfactory for one type of filter or one location, would be altogether unsuited for a different design or different operating conditions.

In general, charging liquids should have a viscosity at 100F and at 0F that will produce a suitable binding medium for the dust. Its surface tension at operating temperatures should not be so high as to prevent the penetration of the dust particles.

Evaporation should not exceed ¾ of 1%. The liquid should be fireproof, odorless, and should be germicidal in its action, to prevent the development of mold spores and bacteria on the filter media.

The National Board of Fire Underwriters has recently issued regulations covering the installation of air filters. These are contained in N.B.F.U. Pamphlet No. 90. (These regulations were printed in the July, 1937 issue of HEATING & VENTILATING, page 53—*Editor.*)

Dry Air Filters

Dry air filters, utilizing felt, cloth, or cellulose sheets as filter media, are available in various forms. Due to the low air velocity through the filter medium and the consequent large screen area required with this type of filter, the filter sheet is usually arranged in the form of pockets to bring the face area of the filter unit within convenient dimensions. The resistance to air flow may be controlled either by replacing the inexpensive cellulose sheets, or in the case of felt medium by dry-cleaning or treatment with a vacuum cleaner.

In Los Angeles and San Francisco it is necessary to clean felt filters, on the average, once every 30 days, and some manufacturers recommend dry cleaning the felts rather than the use of a vacuum cleaner. The necessity for frequent cleaning is due to the accumulation of soot and oil upon the felt surfaces, which stops up the filter much more quickly than larger dust particles and somewhat complicates successful cleaning by the vacuum cleaner method.

Electrical Air Cleaning

The elimination of smoke and similar atmospheric impurities by electrical discharges was suggested by Hohlfeld in 1824. In 1884 Dr. Karl Moeller in Germany and Sir Oliver Lodge in England, working independently, developed practical constructions utilizing this principle. It was not until 1903, however, that the process was made commercially practical by the development work of Dr. F. G. Cottrell of the University of California.

In the Cottrell process the solids are removed by ionization of the air stream, accomplished by passing the air or gas to be cleaned through a high-voltage field. The latter consists usually of an electrically grounded metal cylinder having a high tension wire axially suspended through its center. The dust particles are precipitated upon the interior of the cylinder. The cleaning efficiency of the apparatus is high and it is highly successful in handling many dust problems. The apparatus, however, is expensive and in general ventilation work there has been some hesitancy about the use of the high voltages that are necessary, and the development of free ozone in the process has up to the present time restricted its use in general ventilation.

A considerably simplified design has recently been placed on the market by Westinghouse. The cost of this unit is much less than the Cottrell unit, being 30c. per cu. ft. of air as compared to $1.50 per cu. ft. of air for the Cottrell unit. Free ozone has also been largely eliminated and the apparatus offers many possibilities of development. The manufacturer gives the maximum efficiency of the unit as 80% against visible tobacco smoke when the apparatus is operating at 50% to 60% of rated capacity.

Thermal Air Cleaners

Considerable research is now under way in this country and in England looking to the commercial application of thermal precipitation. As early as the 18th century it was known that if a hot iron were held under a beam of light in a darkened room the dust motes would disappear. It was assumed that the motes were volatilized. Later it was found, however, that the same phenomenon was observed if a piece of ice was held under the dust motes and no adequate explanation of this was available. More recently it appears that this is a phase of molecular activity and the principle has been utilized in the development of a dust count.

How Should a Heating and Ventilating Business be Owned?

1. The Individually Owned Business

By CHARLES R. ROSENBERG, Jr.†

This is the first of a series of articles by the author dealing with the legal aspects of conducting a heating, ventilating and air conditioning business. The first three articles are devoted to a discussion of how the business should be owned, covering the individually owned business, the partnership, and the incorporated business.

THE best way for a heating and ventilating contractor to own his business is not to own it at all. And, believe it or not, the most advantageous move that two contractors in partnership can make is to dissolve their partnership while they have the chance.

The idea is not to quit the heating and ventilating business, but to work out a safe and sensible approach to this somewhat tricky question of ownership. Owning a heating and ventilating business in the right way can and should be the basis of success and security for the owner; but the wrong kind of ownership may bring him loss and disaster.

The one-man heating and ventilating business, for example, has an unpleasant habit of putting the individual who owns it on a most uncomfortable legal and financial spot—and practically always without warning. These unexpected troubles of the contractor who owns his business individually, arise chiefly out of the fact that the law makes no distinction between his business affairs and his personal affairs. If he gets into some personal difficulty that has nothing to do with his business, he is likely to find his business entangled in it just the same. Similarly, his business troubles are apt to come crashing down on his home and involve his personal interests most unpleasantly.

The owner of the one-man heating and ventilating business gets into an automobile accident, let us say, or is sued over a dispute about the bill for some supplies for his home. Presently a judgment is obtained against him—and forthwith he finds his shop, his stock, his fixtures, his equipment and his business bank account attached. The fact that the transaction on which the attachment is based had not the most remote connection with his business does not help him in the least. The law looks upon him as an individual and anything that he owns as an individual is subject to seizure by proper legal process against him.

Taking it the other way around, the owner of the one-man heating and ventilating business jeopardizes everything he possesses in every business trouble he gets into. If he becomes involved in litigation over a business bill, for example, or a chattel mortgage on his fixtures, or a note given in a business transaction, the effects, if he loses, will not be limited to his shop. The successful litigant against him may, if he sees fit, attach the very furniture in the hapless contractor's home or perhaps obtain a lien against the house itself.

In such situations, unhappily, the contractor who owns his business individually cannot separate his business affairs from his personal affairs. A quarrelsome next door neighbor at home may, quite conceivably, bring the "individual" contractor's business to ruin. The more prosperous a contractor who owns his business becomes, the more apt is he to be singled out as a victim for trumped up damage suits and similar schemes. If the scheme is successful, the "individual" contractor must either pay or risk losing his business.

The heating and ventilating contractor who is in business "individually" has one legal method of protecting his business and personal affairs from each other, as it were, but it is a rather dubious one. He can avoid some of his disadvantages by having his personal assets owned by his wife or some other relative. He can legitimately give his personal possessions to someone else while he is solvent and retain enough assets to pay his creditors. If he were to transfer any assets to another person while he was insolvent, his action would be a fraud on his creditors. This device of transferring possessions to someone else is a makeshift at best and must be handled with great care lest it give rise to a suspicion of fraud. Lawyers don't recommend it.

The trouble is that if a contractor is sued or gets into other legal difficulty, his wife's ownership of their home or other assets is at once seized upon as an indication that he's a crook who's trying to evade payment of his just debts. Even if he wins at law, he loses in reputation—which doesn't help his business much!

Difficult as is the legal and financial position of the contractor who owns and operates his business as an individual enterprise, the plight of two contractors in partnership is infinitely more appalling. But, happily, there's a satisfactory legal "out" for both types of heating and ventilating businesses!

†Attorney-at-Law, Media, Pa.

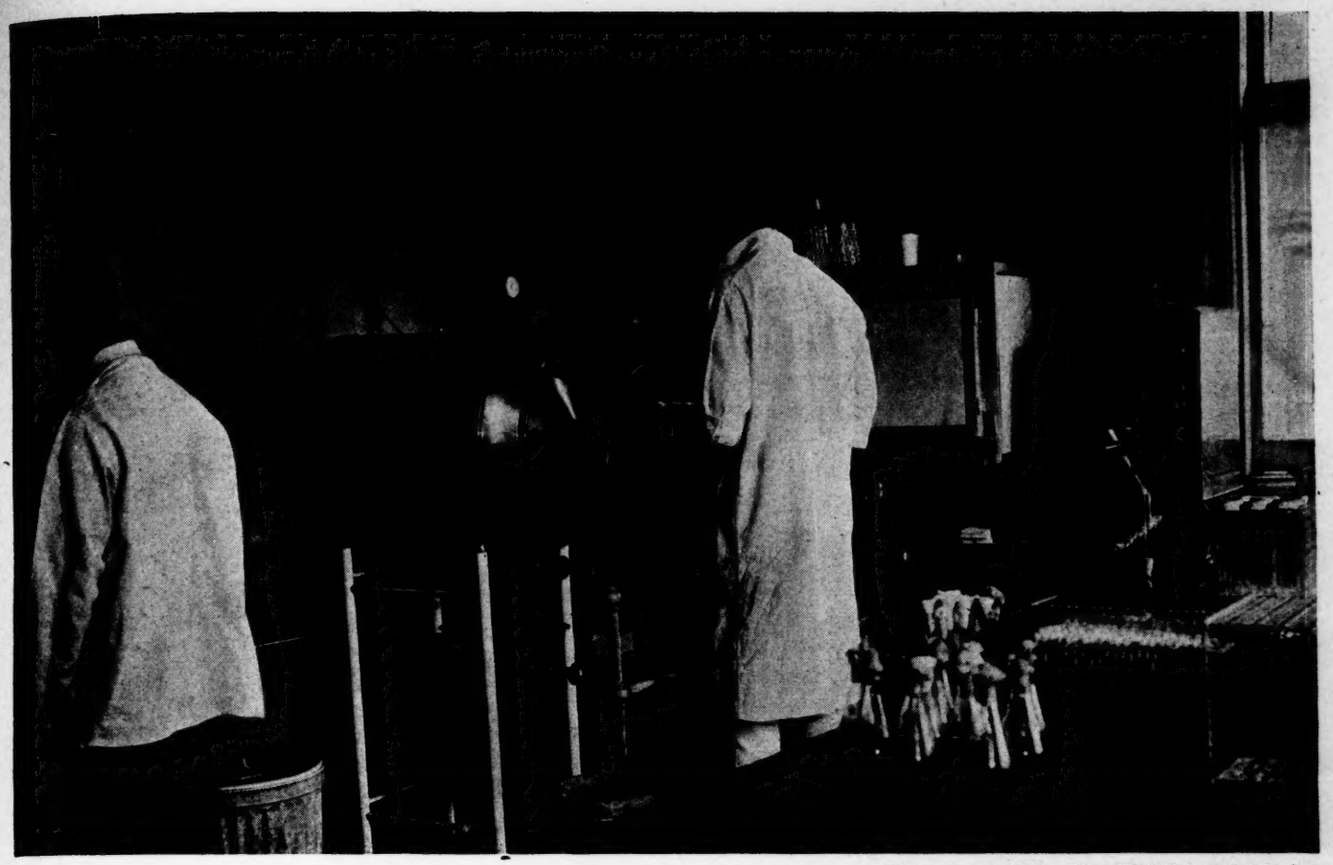


Photo courtesy Photo. Div., WPA Federal Art Project

Air Bacteriology—Measuring Air-Borne Organisms

By ARTHUR CECIL STERN†

THE simplest method of obtaining a sample of the micro-organisms present in the air of any given location is to use the same technique that Pasteur used originally to prove their presence in air. This is merely the exposing of flasks of sterile broth by removing their stoppers and leaving them in contact with the air. After incubation the various organisms will grow in the broth. They may then be plated out from the broth on to agar plates. For several reasons a count of the number of colonies which grow upon a plate prepared in this manner is not a reliable index to the number of bacteria originally present in the air. First, the organisms multiply rapidly while in the broth, so that there are many more colonies on the plate than the number of bacteria which enter the broth, thus rendering the count meaningless. Second, growth of a mixture of organisms in the same medium tends to inhibit the growth of some. This is because a particular medium is not equally nutritious to all organisms, and because the chemical byproducts of the metabolism of some may be detrimental to the growth of others. For instance, the presence of an organism causing strong fermentation, with consequent acid production, would tend to kill any organism present requiring an alkaline medium for growth. Thus, ascertaining the types and number of colonies on the plate does not give a true measure of those entering the broth.

In order to overcome some of these difficulties sterile plates of nutrient agar (rather than broth in flasks) may be exposed to the air by removing the cover and allowing the plate to remain in contact with the air being sampled. After incubating these plates, a colony will grow at each spot on which a living micro-organism fell from the air and found sufficient nutrition in the medium. By varying the type of media used, so that media favorable for all possible organisms in the air, including moulds and yeasts, are utilized, a complete study may be made. The question naturally arises as to what location and for how long plates should remain uncovered and exposed in order to obtain a representative sample. To answer this point, it is necessary to inquire into the mechanism by which micro-organisms are transported, remain in suspension in, and fall out of the air. Our present conjecture is that most air-borne bacteria are attached to a dust particle while in the air, although some spores undoubtedly float alone as if they were particles of dust themselves. Thus the

†Consulting Engineer, New York.

rate of settlement of bacteria is the same as that of dust. However, an appreciable portion of those which eventually settle will be dead by the time they reach the level of the exposed petri dish, because there are lethal factors, such as sunlight, working on the bacteria to kill them all the time they remain suspended. A dead organism will not make its presence known, since no colony will grow on the plate where it falls.

If a clean empty glass dish be placed alongside the dish containing the exposed nutrient agar, the amount of dust falling on the clean dish will be an index to the number of bacteria falling into the plate. The nearer the floor or earth such a receptacle is placed, the more dust-laden air will be above the plate and the greater the possible deposit in a given time. If the plate is placed too close to or on a floor another complication arises, because dust already on the floor is easily stirred up by the motion of people and by drafts. In general, the proper level to expose a plate in a room appears to be about nose height of a sitting person.

Length of Exposure

The question of how long to expose is best solved by the expedient of exposing several plates for different time intervals and choosing the most useful one after incubation. Too short an exposure will result in too few colonies on the plate, so that the plate is obviously not representative of the air being investigated. Too long an exposure will cause the growth of too many colonies, overlapping each other and covering the plate so completely as to make counting and differentiation of colonies difficult if not impossible.

In the test methods described the organisms are allowed to settle on the plate. No measure is possible of the quantity of air in which they were originally contained. Therefore these methods are qualitative rather than quantitative. For a true quantitative test, the air volume must be measured. While it is possible to expose the plate under a large bell jar of known height, a better solution is to aspirate the air through a measuring device so that a known and measurable volume of bacteria-laden air enters, leaves its burden in the device for subsequent incubation, counting and identification, and then exhausts from the sampling device as relatively germ-free air.

Use of Filter

The first and most obvious method for accomplishing the removal of organisms from a measured stream of air is by filtration through a sterile filter. Beds of sand, glass beads and even sugar have been used for filters. For many years the standard method of the American Public Health Association was the sand filter using a 10 mm. deep layer of (through) 100-mesh sterile sand supported on cotton or cloth in a tube 15 mm. in diameter and 10 cm. long with 6 mm. inlet and outlet tubes, top and bottom. The air being tested is passed through the bed at a slow rate. The micro-organisms in the air, since they are mainly on dust nucleii, are retained in the filter with the dust. The air flow is maintained by means of a rotary vacuum pump, a jet type aspirator (actuated by steam, compressed air or water) or by a hand pump. The pressure drop through the filter bed is, in general, too great to allow the use of a centrifugal fan. During a test run, the pressure drop increases as the filter tends to clog up, so that some means of controlling and metering the air must be provided, in the form of valves, bypasses, orifices, flow nozzles, or gas meters. The amount of air that must be filtered depends, of course, upon the concentration of micro-organisms in the air. Where the range cannot be estimated in advance, it is best to run several different filters, each for a different time interval. Because each organism in the filter is allowed to incubate into a colony to indicate its presence, it is more important not to have too many colonies rather than too few. Too many colonies on a plate will make counting very difficult. Therefore, samples as large as those normally taken in tests to measure dust concentration in air need not be taken, because the objective is not the obtaining of large enough samples to weigh or to count under the microscope.

Laboratory procedure in handling a granular sand filter is to shake it out of the filter holder into sterile broth and allow any organisms present to incubate in the broth. From this point on, the sample is treated in the same manner as an exposed flask of nutrient broth.

The difficulties for counting purposes inherent in a broth culture, rather than a direct plate culture, have already been enumerated. The only advantage achieved by using a filter is the knowledge of the quantity of air from which the broth was inoculated. At the same time an element of uncertainty is introduced in that some of the organisms in the air that would have lived had they been allowed to go directly from the air to the nutrient media will be dead and unable to reproduce colonies by the time they are transferred from the sand filter to the media. So many different sorts of substances have germicidal properties for specific organisms that the fewer different substances they contact and environments in which they remain, the more organisms will be alive at time of the counting. Even the most universally adaptable media used in the bacteriological laboratory will not support the growth of all organisms. Similarly, incubation at a temperature at which some thrive most heartily will suppress or kill others which would have thrived at lower or higher temperature.

Dust Measurement

The most common of the dust-measuring methods is the Greenberg-Smith impinger. The impinger for dust operates with the orifice and the impingement surface both under water. It will undoubtedly occur to those familiar with the impinger, that either by substituting a nutrient broth for the distilled water normally used or by the transfer of the distilled water to a nutrient media, the impinger will act as a collector of micro-organisms. The impinger and other liquid aeroscopes which have been utilized in the past have the disadvantages previously enumerated as inherent in the use of a liquid medium. There are obvious advantages to any system whereby substantially all the organisms from a measured stream of air can be caused to grow directly on a solid nutrient agar medium, one colony for each organism that strikes the medium. Such a

system would obviate the errors of not having a measure of air quantity, and of colony growth and multiplication while in liquid medium. For instance, the measured air flow can be directed against a sterile plate so as to impinge a high velocity as it issues from the jet of an impinger type orifice.

Some have questioned whether such high velocity impingement shortens the life of these organisms. For dust retention in the impinger it is not the dust velocity but rather the air stream velocity and the thermodynamic phenomena occurring in a submerged jet that effect retention. When impingement takes place in a liquid medium the material retained is dispersed throughout the medium. When it takes place on a solid medium no dispersion is possible, so that organisms will be retained by that portion of the medium immediately below the jet or not at all. This concentrates the retained organisms in a comparatively small area beneath the jet. This objection can be overcome either by using stationary jets of large area (which is difficult of achievement because of the air velocities and areas involved) or by moving the plate beneath a smaller stationary jet.

Systems by which a magazine of slides or plates coated with sterile nutrient media are caused to laterally traverse the area under a rectangular slit jet have been utilized in specially built devices incorporating sterile magazines and very costly mechanisms for manipulating them. However, no simple device incorporating this general principle is available to the investigator desiring to measure the micro-organism content of air. The author suggests the design of a simple device in which an ordinary petri dish be rotated beneath a radial rectangular slit jet, the rotation of the plate being effected by a worm drive from the same motor driving the fan or vacuum pump, the slit having a length slightly less than the inside radius of the plate so that the impingement would be in an annular ring. By this means, the plate could be marked in crayon in sectors and against each sector impingement effected at different rates of air flow, or different rates of plate rotation, so that fewer plates would be needed to obtain a given number of data. By using various combinations of rotational rate and air flow on different sectors of the same plate, the sector most easily counted could be used and the others disregarded. If the proper combination of these variables is known in advance, different sectors of the same plate could be used to show the change with varying time or location of the concentration of air-borne micro-organisms.

The Wells Centrifuge

In addition to gravitational settlement in still air and kinetic impingement on a nutrient agar surface by means of an air jet, there are other forces which can be called upon to effect the same results. It is doubtful whether thermal or electrical precipitation could be effectively used because the heat and corona discharge would quite likely be germicidal to most organisms. Centrifugal force has been successfully applied in a test unit devised by W. F. Wells, consisting of a rotating metal cylinder in which is placed a glass cylinder (coated on the inside with sterile nutrient agar) with an open top and closed bottom. Inside the glass cylinder is a small diameter metal tube along the axis of rotation. The upper or inlet end of the axial tube bears a calibrated flow nozzle to measure the rate of air flow. The lower end extends almost to the bottom of the inside of the glass tube. Above the glass and metal cylinder, attached to the latter, are a set of fan blades revolving in a stationary casing. The action of this combination is to cause the air to flow down the central axial inlet tube, up inside the glass tube and then out to the atmosphere through the fan. Due to the rotation of the tubes, the air rising through the glass tube is also rotated with sufficient energy to force the dust and micro-organisms outwards until they impinge on the agar on the inside walls of the tube.

Because particles precipitated against the tube wall are of different size, shape and density they deposit quite uniformly over the surface of the agar, tending to concentrate towards the bottom of the tube and thin out towards the top. The glass cylinder, after it has been whirled in the centrifuge for about ten minutes, is removed from the centrifuge and incubated in the same manner as if it were a plate. Prior to insertion into the centrifuge the glass of the cylinder and its cotton plug must be sterile, as must the molten nutrient agar to be coated on the tube wall. A special technique is required to coat the tube with the agar. Molten agar is poured into the tube and the tube whirled on its axis at high speed, preferably with no air flow through the tube. The high rotational energy causes the medium to climb the walls of the tube before solidifying. In most laboratories employing Wells centrifuges the rotation of the tubes during coating is performed in the same machine that is used for sampling. The procedure recommended by the manufacturer of this device is to keep the medium molten in a thermos bottle and to coat each tube just prior to its use for sampling. It is, nevertheless, possible to get good results with these machines using tubes coated in the laboratory, stoppered with a sterile plug and transported to the point of sampling along with the machine, without the necessity of carrying molten medium in a thermos bottle. For the coating of six tubes simultaneously in a laboratory where a large number of tubes were prepared and used daily, the author helped devise a mechanism consisting of six open-topped metal cylinders each geared to a central gear which was belt driven from a motor, with each rotating at the proper speed for coating. Without the use of this whirler, several sampling centrifuges were tied up daily for just the coating of tubes.

When a Wells centrifuge tube has been incubated for 24 or 48 hours at 68F or 98.6F, as the case may be, it is ready for counting. Counting a cylindrical tube coated in the inside presents problems not met in counting the number of colonies on an ordinary petri dish in which the surface of the agar is directly visible. Workers at the De Lamar Institute of Public Health of the College of Physicians and Surgeons, Columbia University, have developed a counting method in which a small electric lamp is inserted into the tube and the tube inserted in a counting grating ruled on transparent celluloid. Thus any portion of the tube may be counted by transmitted light through the agar, glass and celluloid. By marking a reference line parallel to

the axis on the outside of the tube, the tube may be rotated inside the stationary celluloid counting grating.

In most procedures where colonies are counted, it is advantageous to be able to effect a rough classification by type based on a visual observation of the colony morphology. In the case of Wells centrifuge tubes, such differentation must be made on the basis of the appearance of the colony through the glass of the tube and through the medium, a matter leaving something to be desired in comparison with direct observation of the colony itself. However, the hemolysis or the production pigment in blood-bearing media may be observed with equal facility on cylindrical tubes and on plates, and colonies may be "fished" from either type of supporting surface.

One factor which should be considered in any test method involving the flow of a measured volume of air is the question of obtaining a sample from a relatively inaccessible duct through a sampling tube. If there is appreciable removal of micro-organisms in the sampling tube itself, the quantity reaching the medium will obviously be too low. Therefore the velocity in the tube up to the point it enters the medium-containing portion of the measuring device must be high enough to prevent settlement in the sampling tube. Yet, conversely, if the tube has any bends, too high a velocity will allow impingement and possible removal of organisms at these bends. Sampling tubes made of certain substances may exhibit germicidal properties; for instance a plastic formed of a phenol condensed resin, having present some residual phenol, might be highly germicidal towards certain organisms striking and remaining in contact with it for a short period of time. The use of a sampling tube introduces a pressure drop in the flowing air. Devices in which the flow is maintained by means of an auxiliary fan or pump can be built with sufficient excess fan or pump capacity to allow for this draft drop. However, devices such as the Wells centrifuge are limited in the external draft drop that can be permitted without adversely affecting the quantity of air sampled and the micro-organism removal efficiency. In this latter case it must also be noted that the manometer supplied with the instrument is calibrated for free inflow of air. It must therefore be recalibrated for the use of an inlet tube ahead of the flow nozzle.

The whole subject of measurement of air micro-organisms is in a developmental stage with the Wells centrifuge presently holding the center of the stage. With this device pointing the way, the future will undoubtedly bring others. A completely satisfactory test method is yet to be developed. As long as there is question as to the collection efficiency of the measuring device, it is obvious that tests utilizing these methods are also open to question.

The third and concluding article on Air Bacteriology will appear in the December issue.

Application of Air Conditioning in the Textile Industry

ONE of the first applications of air conditioning was in the textile industry. During the early part of this century it was found that by controlling the moisture content of the material a much finer and better product could be secured. Since that time considerable work has been done to determine the proper air conditions which should be maintained. In a recent issue of the "Rayon Textile Monthly," Albert B. Wason summarized the conditions which should be provided in rayon plants. Abstracts of his paper follow:

The textile industry soon learned from experience that by controlling the physical properties of the material in process, a finer quality and better product at a lower cost of production may be produced. It therefore follows that close control of moisture content of the material is of prime importance to maintain the correct physical properties. The absorption or retention of moisture contained in various textile fiber cells is expressed in the percentage of bone dry weight of the material, and this percentage is termed "regain." It is a well known fact that regain will vary with the relative humidity for different types of textile fibers; consequently, control of atmospheric conditions has long been considered most essential to satisfactory and economical production.

In the production of synthetic yarns "rayon," the chemical reactions are controlled by regulation of temperature only without regard to relative humidity up to the spinning process. The air conditioning requirements for the spinning of acetate and viscose process yarns are very similar. The process requires year-round air conditioning by means of a central station spray system to maintain not less than 70% relative humidity and a room temperature of 80-85F. The grading, sorting, warping, winding, twisting, coning and quilling processes require a relative humidity of 55 to 60%, with a varying room temperature within normal limits of 85 to 90F.

For the weaving and knitting of all-rayon fabrics, a relative humidity of 65% has proven satisfactory with varying temperatures within normal limits. A rayon, all-acetate fabric requires a high relative humidity of 70-75%. Cotton fabrics on the new high speed looms require higher degrees of relative humidity and it is desirable to maintain the weave room at 80 to 85% relative humidity, with varying room temperatures.

It therefore follows when weaving mixed fabrics, the relative portions of the different fibers must be taken into consideration, and a compromise made based on the difference in normal stretch of the mixed fibers. For example, in the case of cotton and acetate rayon mixture, relative humidities of 65-75% are required. The important factor, however, is that constant humidity must be maintained.

When weaving staple rayon mixtures, the relative proportions of the weaker fibers may require relative humidities maintained well above the conditions for all-rayon weaving. Another factor, aside from the fiber consideration, is the effect of atmospheric conditions upon the loom harness. Constant relative humidities will promote higher loom efficiency and produce a more uniform quality product.

Field Measurements and Their Interpretation

By JOHN L. ALDEN

EVERY engineer actively concerned with exhaust matters has frequent need for test data. The designer needs hood coefficients, conveying velocities and the quantity of air required to transport a pound of material. The contractor's sales engineer must test existing systems as a preliminary to quoting on additions and alterations and to establish the basis for the sale of power-saving fans and separators. Also, he must be able to check newly completed systems with the purchaser's engineer in order to obtain acceptance before the erecting mechanics leave the job. The factory inspector must test systems daily to determine the degree of compliance with state codes. Lastly, the plant engineer responsible for maintenance must supplement visual inspection with pneumatic tests if he is to be certain that his exhaust systems remain in efficient condition.

Manometers

The most useful single instrument in exhaust work is the common "U" tube. Static pressures are measured by this device without the aid of other instruments. A fairly comprehensive study of a system may be made with no other apparatus than a water-filled pocket "U" tube. Even the air volume may be estimated within reasonable limits by an experienced man who knows what data to take and how to analyze his figures.

The Impact Tube

A simple instrument of great value is the impact tube, several varieties of which are shown in Figs. 102a

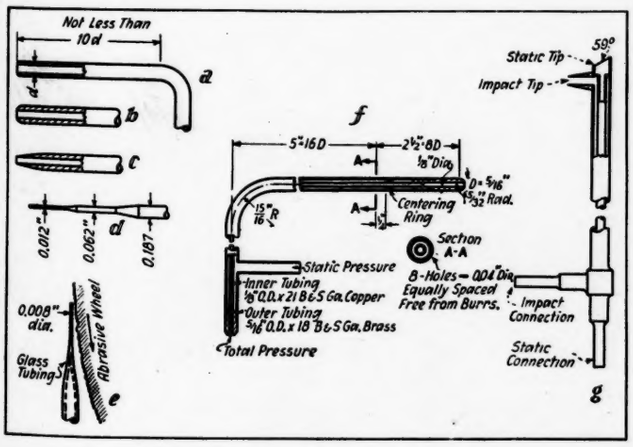


Fig. 102. Impact and pitot tubes.

to e, inclusive. This instrument, connected to a manometer, will measure the impact or total pressure when pointed upstream in an air current. The velocity pressure is obtained by deducting the static pressure measured in the same cross-sectional plane of the pipe.

The impact tube is a primary measuring device of high inherent accuracy. No calibration is necessary because its performance is in exact accord with theory. It is not recommended for velocities much less than 2000 f.p.m., unless connected to some form of multiplying pressure gage such as the inclined manometer. Large percentage errors are possible under field conditions when reading pressures less than ¼ in. of water on the ordinary "U" tube.

The Pitot Tube

The commercial pitot tube combines the impact tube previously described with means for measuring static pressure. In its conventional form, Fig. 102f, it consists of two concentric tubes, the inner forming the impact tip and the outer constituting the chamber into which open the static pressure holes. When the inner and outer tubes are connected to opposite legs of a single manometer, the latter indicates the velocity pressure directly. Two manometers are required if the static pressure must be read separately.

Static Pressure Holes in Pipe Walls

Static pressure measurements in factory exhaust systems are generally made through the pipe wall. The size of the hole is not critical since reliable readings may be obtained from holes ranging in diameter from 0.020 in. to ¼ in. and more. A convenient size which may be drilled with a light hand drill without excessive drill breakage is 1/16 in. The inner end should be free from burrs. For field work, however, the removal of the inner burr may be difficult and, if so, is seldom worth the effort. Most field measurements are made and recorded in terms of tenths or twentieths of an inch and hence are rough as compared with laboratory standards. In consequence, many of the customary precautions to insure accuracy are in fact unnecessary refinements.

Location of Static Pressure Holes

True static pressure can be measured by the pitot tube or at holes in the pipe wall only if the air stream

flows parallel to the surface containing the static orifices. The selection of the measuring location, therefore, must be made with considerable care. While the laboratory technician can insure parallel flow past the measuring station by the use of long lengths of upstream piping or by the insertion of flow straightening devices, the field engineer must accept conditions as he finds them. Many of his measurements must be made in places where it is obvious that non-parallel flow is present. His only course is to select the least objectionable location and to drill two or more holes equally spaced around the circumference of the pipe. The interpretation of the pressures measured at these points may require considerable skill. Sometimes the readings should be averaged and sometimes one or more should be discarded. Intuition and air flow "sense" often are the engineer's sole guide.

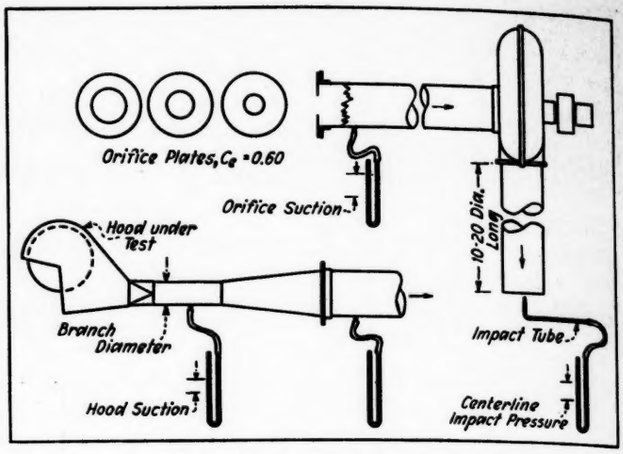
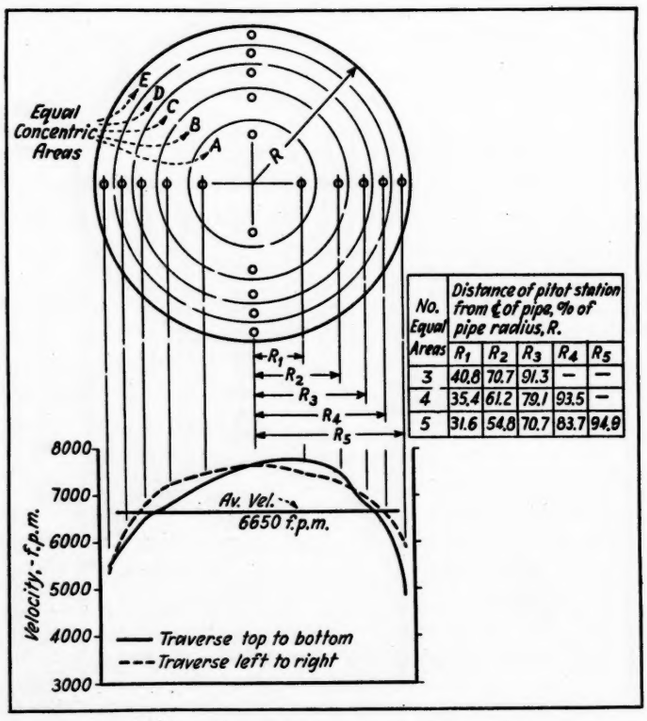


Fig. 107. Test fan for obtaining hood coefficients.

Pitot and Impact Tube Traverses

The velocity across a given section of pipe is never uniform. Furthermore, flow conditions in exhaust piping are seldom such that the theoretical velocity distribution, Fig. 8, is attained. Consequently, a single pitot tube measurement seldom can be translated into average velocity across the section. Velocities must be measured at several points and an average taken, weighting each velocity by that fraction of the total pipe area which it represents. The usual practice is to divide the pipe area into imaginary rings of equal area and to measure the velocity pressure at four points in each ring along two diameters at right angles to each other. The four measuring stations in each ring are located on an imaginary circle which divides the ring into two equal concentric areas.

Fig. 103 shows a typical traverse. In the accompanying table the radii of the measuring stations are expressed in terms of the pipe radius. Ten readings are taken on each diameter, plus a centerline reading. These are translated into velocities and the 20 zone velocities averaged, omitting the centerline velocity. Velocity pressures must not be averaged since they are proportional to the squares of their respective velocities.



No. Equal Areas	Distance of pitot station from ℄ of pipe, % of pipe radius, R.				
	R_1	R_2	R_3	R_4	R_5
3	40.8	70.7	91.3	—	—
4	35.4	61.2	79.1	93.5	—
5	31.6	54.8	70.7	83.7	94.9

Fig. 103. Typical pitot or impact tube traverse.

Pitot station radii are given in Fig. 103 for 3, 4 and 5 zones. Five zones, or 20 points, should be used for pipes 10 in. in diameter and larger, four zones from 5 in. to 10 in., and three zones for smaller pipes. When time is limited, it is better to take 6 readings on each of two diameters or 12 readings, total, than to take 10 readings on a single diameter.

Testing Facilities for Measuring Hood Coefficients

Since the entire design of an exhaust system hinges on the volume of air entering the hoods, entry coefficients of fair accuracy are essential. Sometimes these may be synthesized successfully but often an actual trial is necessary. For the latter, cheap hood models may be made from wall board, light sheet metal, plywood or even stiff cardboard. These may be piped to any source of suction and the flow measured at one or more pressures. The actual flow may be compared with the theoretical flow as computed from the hood suction and branch pipe area. The ratio of actual to theoretical flow is the entry coefficient.

The designer should collect and analyze entry data on as many forms of commercial hoods as possible. Hoods in place on the machines they serve may be tested during noon hour. Trial models are best tested with a special setup similar to that shown in Fig. 107. No elaborate equipment is needed. A discarded fan and a few lengths of pipe, some home-made orifices, a few "U" tubes and an impact tube constitute the apparatus.

The discharge pipe is traversed at the open end and the ratio between the centerline velocity and the average velocity determined. This is done for two or three different inlet openings to be sure that the ratio is accurately established. Thereafter, the centerline velocity pressure alone need be measured. The volumes computed from the discharge pipe traverses may be checked against the volumes computed from the orifice areas, coefficients and suction pressures.

The hood under test is substituted for the inlet orifice plate and the suction measured. The theoretical air volume at $C_e = 1.0$ is computed from the expression

$$Q = 4008\, a\sqrt{h}$$

where a = area of hood branch pipe and
h = static suction in the branch.

The actual volume flowing is obtained from the product of the discharge pipe area, the centerline velocity and the previously established ratio between the average velocity and the centerline velocity. The coefficient of entry of the hood is

$$C_e = \frac{\text{Actual volume}}{\text{Theoretical volume}}$$

Tests to Establish Conveying Velocities

It has been emphasized that the conveying velocities quoted in Tables 5 and 20 are not always the minimum allowable. The designing engineer should take every opportunity to obtain specific data concerning conveying velocities for the identical materials in which he is interested. If an existing system handling these substances is available he should examine it for clogged pipes or for pipes which show signs of incipient settlement. Velocities in these pipes may be measured during noon-hour or other periods when no solids are flowing. Velocities should be measured in other pipes which are free from clogging troubles. The high and low values thus obtained evidently bracket the minimum allowable air speeds. These the engineer can select with very little difficulty. Sometimes a study of this nature indicates that the velocities all over the system are higher than need be and that the fan speed can be reduced to save power.

Tests to Check Design Assumptions

Every design involves some degree of speculation. Some assumptions have been necessary and some design data have been incomplete or possibly inaccurate. Consequently, every new system should be checked against the original design figures. The first step is to check the fan speed. Next, static pressures are measured at all significant points. These include the suction at each hood, suction and back pressure at the fan and the pressure drop through the separator. The original pressure and flow sketch similar to Fig. 59 should be used to select points for measurement in the suction main. If there is a long straight run of discharge pipe, the static pressure should be taken at each end so that the friction loss may be checked against the friction chart, Fig. 44.

If the static pressures as measured check closely with the predicted pressures, it may be assumed that the air quantities are the same as those calculated. Exact agreement is rare, however, first, because our design factors are not sufficiently well established and, second, because the erecting mechanics will have made small departures from the original piping plan. Usually there will be a few places at which the test figures differ materially from those calculated. The engineer must then use his knowledge of air flow laws to deduce the reasons for the departure. Often it will be unnecessary to make changes in the physical system but the information obtained should be recorded and interpreted so that future designs may embody the lessons learned.

Tests of Systems for Maintenance Purposes

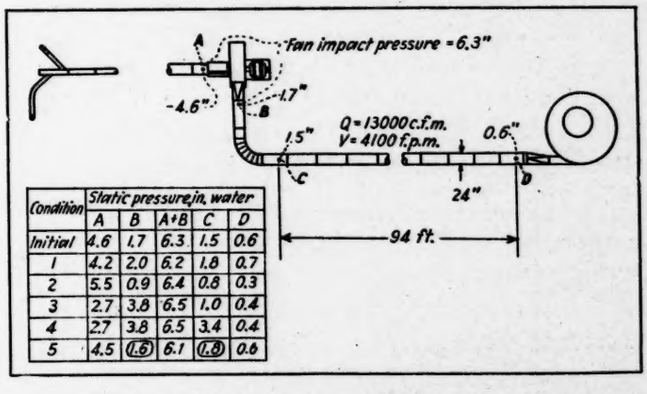
The initial static pressures of a newly installed system should be recorded on a diagram similar to Fig. 59. Random measurements taken at later dates will indicate whether operating conditions within the system have changed materially since the system was first put into service. Fan suction and back pressure are the fewest data which will give useful information. It is preferable to check the suction at all hoods as well. If significant departures are found, further measurements will isolate the trouble. Semi-annual or annual tests are sufficient in most cases but systems which are vital from a health or safety standpoint should be inspected visually and with the manometer at more frequent intervals.

Locating and Diagnosing Trouble

In Fig. 109 are recorded certain pressure data obtained at the time of installation of a new system. The accompanying table indicates certain pressure changes as measured at various later dates. Each pressure change signifies a change in resistance of some part of the system. Correct interpretation of recorded variations enables the maintenance man to find and correct troubles promptly and economically. The analyses of the pressure readings of Fig. 109 are as follows:

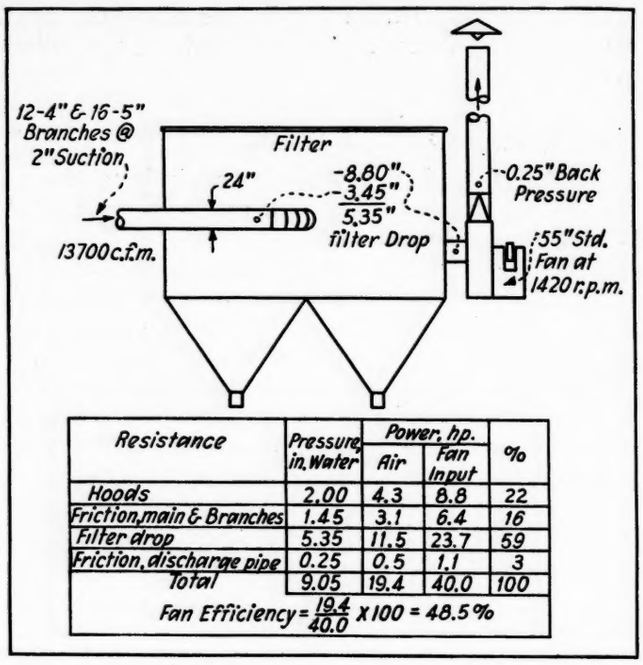
Condition 1. The fan suction has dropped and the fan back pressure has increased by nearly the same amount. A small drop has taken place in the fan impact pressure. The friction loss in the discharge pipe has increased as has the cyclone resistance. The latter changes indicate a definite increase in air flow rate. This can come only from decreased resistance on the suction side of the fan. The maintenance man should look for disconnected hoods, open floor sweeps, open handholes and missing caps at the ends of mains and branches.

Condition 2. The fan suction has increased materially while the back pressures at B, C, and D have dropped. Reduced discharge resistances indicate a drop in air volume. The increased suction means increased inlet resistance. Closed blast gates or a clogged suction main will produce this pressure condition. If



Condition	Static pressure, in. water				
	A	B	A+B	C	D
Initial	4.6	1.7	6.3	1.5	0.6
1	4.2	2.0	6.2	1.8	0.7
2	5.5	0.9	6.4	0.8	0.3
3	2.7	3.8	6.5	1.0	0.4
4	2.7	3.8	6.5	3.4	0.4
5	4.5	(1.6)	6.1	(1.8)	0.6

Fig. 109. Changed conditions within exhaust system as indicated by static pressure measurements.



Resistance	Pressure in. Water	Power, hp. Air	Power, hp. Fan Input	%
Hoods	2.00	4.3	8.8	22
Friction, main & Branches	1.45	3.1	6.4	16
Filter drop	5.35	11.5	23.7	59
Friction, discharge pipe	0.25	0.5	1.1	3
Total	9.05	19.4	40.0	100

Fan Efficiency = $\frac{19.4}{40.0}$ X 100 = 48.5%

Fig. 110. Power requirements of exhaust system elements.

there is a previous history of clogging trouble, design changes may be indicated.

Condition 3. An abnormal pressure drop has taken place between the fan outlet and the downstream side of the elbow. An obstruction will be found between B and C, probably at the elbow. The impact pressure at the fan has increased while the discharge pipe friction and the collector loss have diminished. These factors indicate reduced volume.

Condition 4. This situation is similar to that of Condition 3 except that the large pressure drop occurs between C and D. Measurement at intermediate points will indicate whether the obstruction is localized or whether it has persisted long enough to cause general settlement throughout the pipe.

Condition 5. It will be observed that the pressure at C is recorded as being greater than that at B. There is nothing wrong with the system; the observer has misread his instruments or has transposed the figures. This is a common mistake which often passes unnoticed by inexperienced engineers. It represents an impossible condition since true static pressures, both suction and positive pressure, are greatest in numerical value at the fan and diminish as the distance from the fan increases. The only exception is the rare instance in which velocity pressure is converted to static pressure by means of an efficient expansion piece.

Power Requirements of System Elements

The air horsepower consumed by any resistance element may be computed from the general formula for air horsepower,

$$Ahp = 0.000157\ Q\ h$$

where Q = the volume rate of flow, c.f.m., and
h = the pressure drop across the resistance, in. of water.

When several resistances are in series so that the same air volume passes through each, the power consumption of each is in proportion to its static pressure drop. This is illustrated in Fig. 110 which represents the fan and filter of a system handling abrasive dust. The table shows the pressure drop through each of the principal elements of the system. The air horsepower has been calculated and the fan input power determined by test. The power consumption has been broken down in proportion to the resistance of each element and a column has been added to show the percentage of the whole which each element represents. It will be observed that the process of removing the dust from the machines and conveying it to the filter has required only 38% of the total power. The cleaning operation, on the other hand, has consumed 59%.

Power Reduction

A static pressure analysis of a system often uncovers cost reduction opportunities. Referring again to Fig. 110, it is plain that no power can be saved by reducing hood suction if this is already at the minimum level permitted by the local code. The main and branch pipe friction appears to be reasonable although closer study of pressures taken at intermediate points may disclose some source of loss warranting attention. The discharge pipe friction loss represents such low power consumption that it offers no opportunity for worthwhile savings. The pressure drop through the cleaning plant, on the other hand, is obviously excessive. The fan efficiency, also, is lower than need be.

Several steps to reduce the power consumption are possible. The choice will depend upon the value of the power saved, the cost of changes and such local factors as the age and condition of the present equipment. A filter whose resistance is not more than 2.5 in. of water can be obtained, in which case about 12 hp. will be saved. An alternative is to duplicate the existing separator, connecting both in parallel so as to halve the velocity through the filter cloth. The expected power saving again will be about 12 hp. For reasons not apparent in the example, it may be best to break the system into two parts, using the present fan and filter for one and providing new equipment for the second system.

The 55-in. fan is overloaded. A 70-in. fan of the same type and make will operate at about 57% efficiency when connected to the present system. A fan of the slow speed type of a size suitable for the load will operate at not less than 65% efficiency. The various combinations of fans and filters, together with the resulting saving both in horsepower and in per cent of present power may be tabulated as follows:

	Saving, Hp.	Saving, %
Present filter, 5.35 in. drop		
Larger fan, same type	6	15
Larger fan, slow speed type	10	25
New filter, 2.50 in. drop		
Filter only, present fan	12	30
Filter, larger fan, same type	16	40
Filter, larger fan, slow speed type	19	47

A similar tabulation evaluating the cost of each change and its saving in dollars will permit an intelligent decision as to the extent to which power-saving changes will be profitable.

Temperature and Availability of Well Water

The two principal factors which limit the use of well water for cooling air are its availability and temperature. It is the purpose of this section to give information on both of these.

Sub-surface Water Temperatures

At the surface of the earth the temperature of the ground (and its water) approaches that of the air and tends to fluctuate with air temperature. As the depth increases the annual range of water temperature decreases until at about 30 ft. below the surface the water temperature remains practically constant the year round at a temperature slightly above the average (annual) air temperature. W. D. Collins, in his study of water temperatures for the U. S. Geological Survey, concluded that at depths from 30 to 60 ft. the temperature of water in non-thermal wells is about 2 to 3F above the mean annual air temperature.

The accompanying table, giving probable well water temperatures for 100 cities, is based on this general conclusion, and the figures are the average annual air temperatures for those cities plus 3F. The iso-thermal lines on the colored map were plotted from similar figures for a larger number of cities. These data apply only to non-thermal wells 30 to 60 ft. deep. For deeper wells, add to the figures given 1F for each additional 64 ft. beyond 50 ft.

Temperature Requirements

Water can be used in sprays or surface coils for cooling air directly at temperatures above 55F if only sensible heat is to be removed by the water. If both latent and sensible heat are to be removed by the water from the air, however, the maximum water temperature which can be used depends on the ratio of the sensible to the latent heat load. In general, for most comfort jobs, this ratio is such that the maximum water temperature which can be used is about 55F.

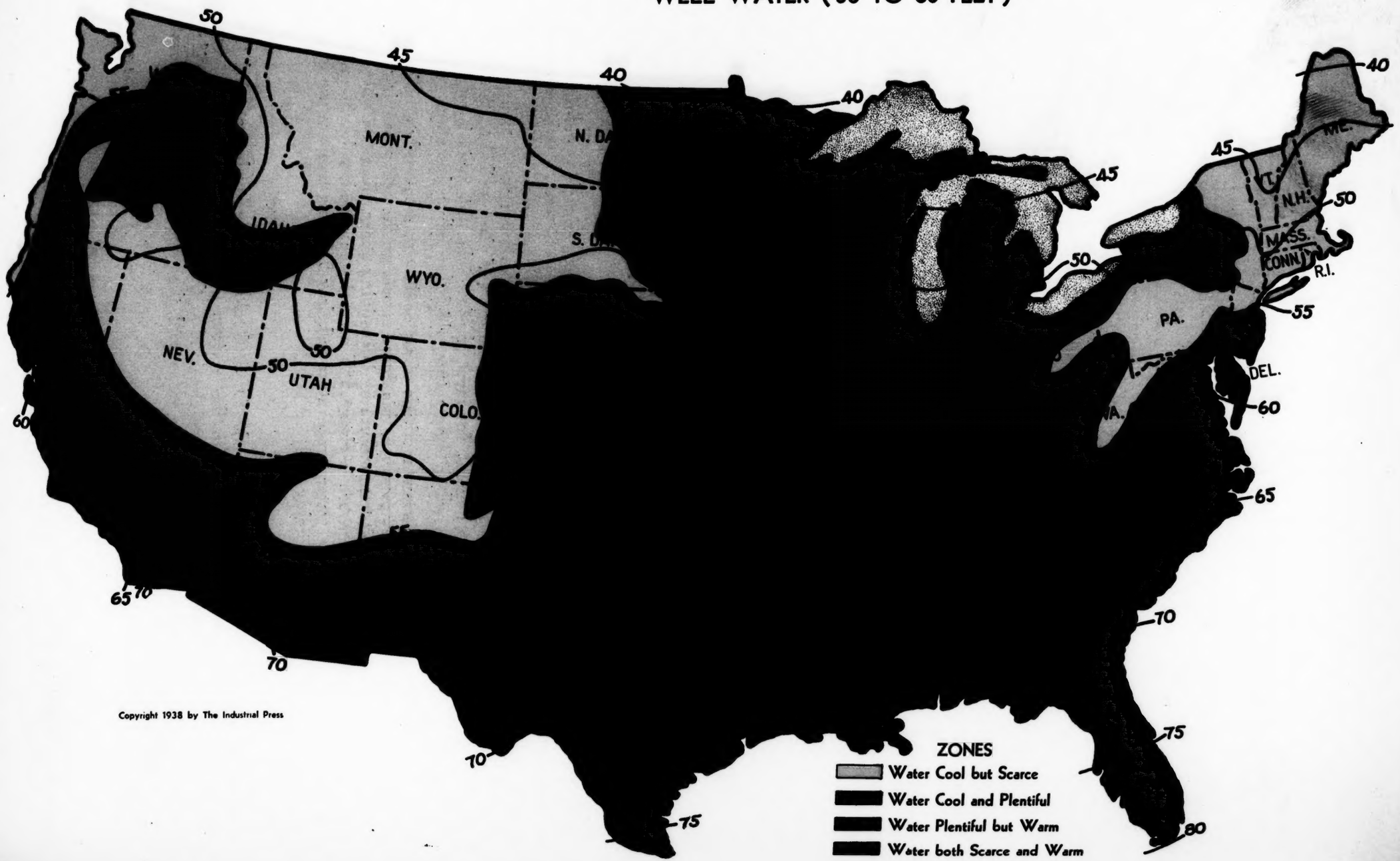
Because current methods of air cooling so frequently are limited by the 55F temperature, this figure is used in the accompanying map as the limiting temperature in determining zones. Regions where the water temperature is above 55F are characterized as having warm water; if the water temperature is below 55F, the temperature is regarded as suitably cool.

Availability of Water

O. B. Meinzer of the U. S. Geological Survey has studied the availability of water in the various ground water provinces, and these provinces have been classified as those with relatively plentiful supplies, and those where, in general, the supply is scarce or at least

Text continues following Map and Table.

PROBABLE TEMPERATURE AND AVAILABILITY OF WELL WATER (30 TO 60 FEET)



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PROBABLE TEMPERATURES OF WATER IN 30 TO 60 FT. WELLS IN 100 CITIES

City	Temperature, F.	City	Temperature, F.
Albany, New York	51	Memphis, Tennessee	65
Albuquerque, New Mexico	59	Meridian, Mississippi	67
Atlanta, Georgia	64	Milwaukee, Wisconsin	49
Baltimore, Maryland	58	Minneapolis, Minnesota	47
Birmingham, Alabama	67	Minot, North Dakota	42
Boise, Idaho	54	Mobile, Alabama	70
Boston, Massachusetts	53	Newark, New Jersey	55
Buffalo, New York	50	New Orleans, Louisiana	72
Burlington, Vermont	48	New York, New York	55
Butte, Montana	45	Norfolk, Virginia	63
Charleston, South Carolina	69	Oklahoma City, Oklahoma	63
Charlotte, North Carolina	63	Omaha, Nebraska	54
Cheyenne, Wyoming	48	Paterson, New Jersey	55
Chicago, Illinois	52	Pensacola, Florida	71
Cincinnati, Ohio	58	Peoria, Illinois	54
Cleveland, Ohio	52	Philadelphia, Pennsylvania	57
Columbia, South Carolina	67	Phoenix, Arizona	73
Columbus, Ohio	54	Pittsburgh, Pennsylvania	56
Concord, New Hampshire	49	Portland, Maine	48
Dallas, Texas	69	Portland, Oregon	56
Denver, Colorado	53	Providence, Rhode Island	52
Des Moines, Iowa	53	Pueblo, Colorado	55
Detroit, Michigan	51	Reading, Pennsylvania	56
Duluth, Minnesota	41	Reno, Nevada	53
El Paso, Texas	67	Richmond, Virginia	71
Erie, Pennsylvania	52	Rochester, New York	51
Eugene, Oregon	55	St. Louis, Missouri	59
Evansville, Indiana	60	Salt Lake City, Utah	55
Fitchburg, Massachusetts	51	San Antonio, Texas	72
Flagstaff, Arizona	49	San Diego, California	64
Fort Smith, Arkansas	64	San Francisco, California	59
Fort Wayne, Indiana	53	Savannah, Georgia	70
Frederick, Maryland	57	Scranton, Pennsylvania	53
Grand Forks, North Dakota	41	Seattle, Washington	54
Grand Rapids, Michigan	51	Shreveport, Louisiana	69
Great Falls, Montana	48	Sioux City, Iowa	51
Greensboro, North Carolina	62	Sioux Falls, South Dakota	49
Hartford, Connecticut	53	South Bend, Indiana	53
Houston, Texas	72	Spokane, Washington	51
Huntington, West Virginia	58	Springfield, Illinois	56
Indianapolis, Indiana	56	Syracuse, New York	50
Jacksonville, Florida	72	Topeka, Kansas	57
Kansas City, Missouri	58	Trenton, New Jersey	57
Knoxville, Tennessee	61	Tulsa, Oklahoma	64
Lexington, Kentucky	58	Vicksburg, Mississippi	69
Lincoln, Nebraska	54	Washington, District of Columbia	58
Little Rock, Arkansas	65	Wheeling, West Virginia	56
Los Angeles, California	66	Wichita, Kansas	59
Louisville, Kentucky	60	Wilmington, Delaware	57
Madison, Wisconsin	49	Yuma, Arizona	75

not usually plentiful. A plot of availability from Meinzer's data has been superimposed on a map of temperatures, so that the resulting colored map presented here shows vividly the regions where well water probably is or is not available and is or is not of a temperature suitable for use in the usual surface coils or open sprays.

What the Map Shows

On the map the iso-therms show the expected temperatures of ground water at depths from 30 to 60 ft. Temperatures of water from deeper wells can be determined by adding to the figures shown as previously explained, so that from the iso-thermal lines one can determine the probable temperature of ground water, whatever its use, if the depth of well is known.

In addition, the colors show the availability of well water. Well water is generally available in the regions where the colors are blue or orange; it is relatively scarce in the brown colored zones, both plain and hatched.

The four zones give information as to both availability and temperature for certain uses. Since 55F is the limiting temperature for certain uses, the orange colored zone indicates regions where water is both plentiful and below 55F; the blue where it is scarce and below 55F; the brown where it is warmer than 55F but plentiful; the hatched brown where it is above 55F but scarce. These four regions, therefore, show where one can expect to use or not use well water for comfort cooling when the water is to be used for extracting directly from the air both latent and sensible heat (in other words both cooling and dehumidifying) with surface coils or sprays.

What the Zones Do Not Show

Water can be used for cooling air directly at temperatures higher than 55F if only sensible heat is to be removed by the water. Warmer water is also useful for cooling condenser water. The isotherms show what temperatures of water can be expected but the colored zones, being based on 55F temperatures, do not show the suitability of well water for such purposes. However, from the isotherms and the availability zones, similar maps can easily be drawn based on other temperatures.

The map is naturally generalized and must not be interpreted too literally. Occasional wells will be found in the scarce zones; satisfactory temperatures may be found at times in the warm zones. On the whole, though, the general picture is accurate.

Heat Required to Defrost Windshields

SOME years ago the writer devoted considerable time to the development of a windshield defroster, making use of a small blower and warm air.

Observations made from time to time on one of the main New England highways showed the temperature range producing sleet to be practically confined to the limits included between 28 and 34F, while the point at which most frosting occurred was 30 to 32F.

The next step in this work was to design a diffusing nozzle, which, with a given discharge velocity, would spread the air over a maximum glass area.

After many trials, that shown in Fig. 1 was found to be the most effective. The discharge outlet in this case was 3/16 in. x 7 in. and the air velocity 1100 f.p.m., making the volume handled practically 10 c.f.m.

With warm air at suitable temperatures, as described later, this nozzle would clear a heavy coating of ice over a space having an area of about 190 sq. in.

A general layout of the apparatus employed in making the tests is shown in Fig. 2. This was set up in an unheated room, using the lower half of a window for the glass surface and running the tests when the outside temperature ranged from 28 to 32F.

Air temperature was varied by turning the wick of the lamp B up or down and the volume regulated by means of a damper C (see Fig. 2). A thermometer D in the discharge pipe from the blower A indicated the temperature of the air thrown upon the glass.

The first series of tests was carried out with still air on the outside, and was made to determine what temperature of air must be blown upon the glass to maintain a clear space of about 190 sq. in. area, while the volume and velocity remained as previously noted.

During this time a fine spray of cold water was thrown upon the outside of the glass. A considerable number of tests were made covering a somewhat larger range than 28 to 34F, and the results plotted in a curve. Figures taken from this are given in column 2 of the accompanying table.

The next series of tests was made in a similar manner for the same outside temperatures, but with a blast of air upon the outside (see blower E, Fig. 2) to give the effect of a car in motion. The results are shown in column 3 of the table.

Outside Temp., F	Temp. of Air Blown Upon Glass to Prevent Freezing, F	
	Without Wind	With Wind
28	37	90
29	36	85
30	35	80
31	34	75
32	33	70

Assuming the warm air jet to be cooled to the outside temperature, the heat supplied under test conditions for an outside temperature of 30F will be (35 — 30) times 10 divided by 55 equals 0.91 B.t.u. per min., or 54.6 B.t.u. per hr.

When the outside air blast is turned on, the warm air jet is cooled through 50F, instead of 5F, to produce the same defrosting results. That is, the heat supplied must be increased ten times, which is an important factor where high air velocities enter into problems involving heat transmission.

With an outside temperature of 30F and the air blast in operation, the heat requirements were found to be $54.6 \times 10 = 546$ B.t.u. per hr., or $546 - 190 = 2.9$ B.t.u. per sq. in. of clear space on the glass.

In heated cars the use of a small disc fan for blowing air directly upon the windshield seems to give very satisfactory results for defrosting purposes.

Here the conditions and results are much the same as in the tests illustrated in Fig. 2.

While the temperature around the steering wheel in sleet-forming weather will ordinarily be somewhat less than that given in the third column of the table, the quantity of air blown upon the windshield will probably exceed that in the tests, and at the same time the cleared space will be somewhat smaller, so that the heat actually supplied per square inch of surface per hour will closely approximate that indicated by the tests.—*Charles L. Hubbard.*

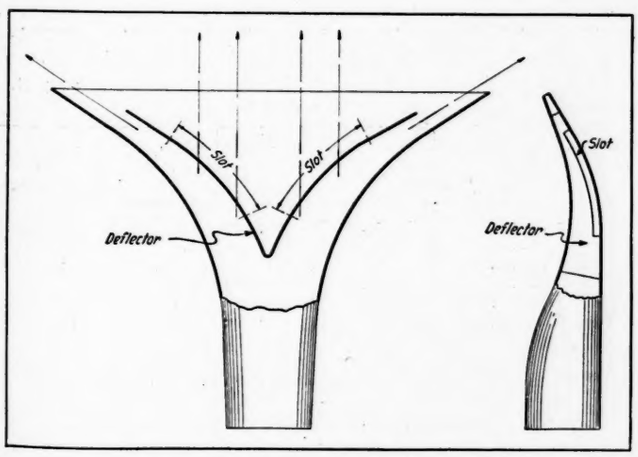


Fig. 1. Detail of diffusing nozzle

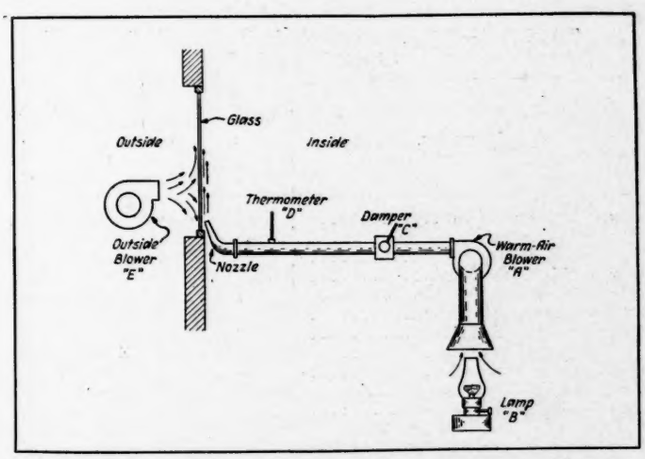


Fig. 2. Apparatus employed in making tests

Calculating Vapor and Heat Transfer Through Walls

By L. G. MILLER†

During recent years there has been much discussion concerning the passage of moisture through building materials, the possible or probable damage resulting therefrom and the methods of correction. The author here summarizes the trend of some opinions on this subject. This has been abstracted from a paper presented at the 1938 mid-year convention of the National Warm Air Heating and Air Conditioning Association

THIS summary emphasizes three issues: (1) A method of analysis; (2) Quantity of vapor passing through; and (3) Proposed corrective methods.

The method of analysis may be developed from Fourier's equation of flow in steady state in a manner similar to the development of the equation for heat transfer, and the resulting equation is exactly similar. In order to make the method applicable to all cases, values for the conductivity of vapor, quite generally called *permeability,* would be required. Considerable work has been done along this line by private laboratories considering only the product in which they are vitally interested and expressing the results in the unit fitting their particular needs. In Table 1 a few such values are presented. Some of them were determined in our own laboratory and some calculated from published data.

The unit used in this table for conductivity or permeability is *grains per square foot per hour with one pound per square inch difference in vapor pressure.* A modification of the Gardner jar method has generally been used in determining the values, with temperatures varying from 70 to 80F and vapor pressure differences of 0.35 to 0.75 lb. per sq. in.

Just as a review for those who are not regularly making this type of study. Table 2 shows the method of calculating the heat conductivity coefficient of a wall and the resulting temperature drops through the various composite members.

In an exactly similar manner, Table 3 shows the calculation of the drop in vapor pressure through a wall of ordinary construction with loose fill insulation and the resulting dewpoint temperature. These values are plotted in Fig. 1. The fact that the temperature and dewpoint gradients cross in the wall shows that condensation will occur, and since the temperature in that

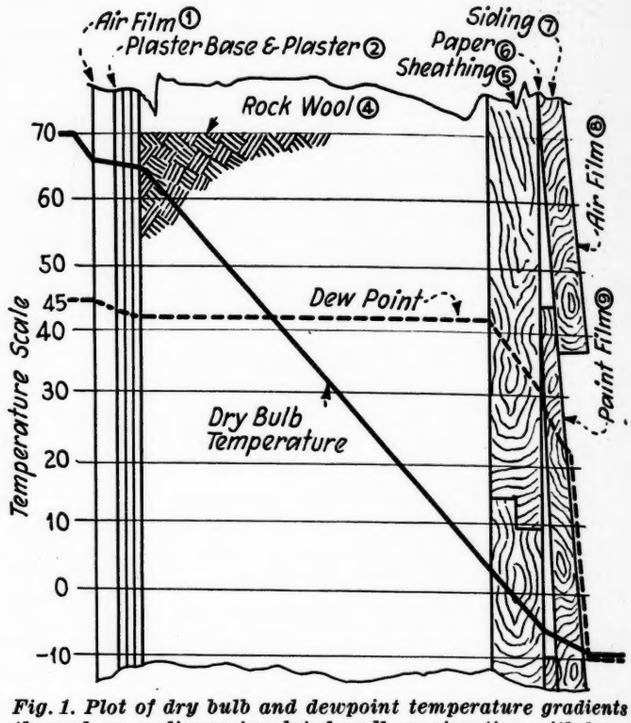


Fig. 1. Plot of dry bulb and dewpoint temperature gradients through an ordinary insulated wall construction with loose fill insulations.

†Head, Dept. of Mechanical Engineering, Michigan State College.

TABLE 1—HEAT AND VAPOR TRANSMISSION COEFFICIENTS

Material	Heat		Vapor	
	C_h	$\frac{1}{C_h}$	C_v	$\frac{1}{C_v}$
1.—Inside air film	1.65	0.61	—	Neg.
2.—¾-in. plaster base and plaster	4.40	0.22	30.0	0.033
3.—Vapor barrier†	—	Neg.	1.65	0.6
4.—3½-in. rockwool	0.077	13.0	—	Neg.
5.—¾-in. fir sheathing	0.71	1.41	6.0	0.17
6.—Waterproof paper			100.0	0.01
7.—Pine lap siding	1.28	0.78	10.0	0.10
8.—Outside air film	6.00	0.17	—	Neg.
9.—Paint film‡	—	Neg.	7.0	0.143
10.—¾-in. Celotex	0.44	2.28	25.5	0.04
11.—4-in. brick masonry	2.30	0.435	2.2	0.45

†Values published by Kimberly Clark Corp.
‡Values published by the Technical Committee of the New York Paint and Varnish Production Club.

TABLE 2—TYPICAL CALCULATIONS OF TEMPERATURE DROP THROUGH A COMPOSITE WALL
(Wall having heat transmission of 4.94 B.t.u. per sq. ft. per hr.)

Material (See Table 1)	$\frac{1}{C_h}$	Temp. Drop	70— Cumulative Temp. Drops
1	0.61 × 4.94 =	3.0	67
2	0.22 × 4.94 =	1.0	66
4	13.00 × 4.94 =	64.0	2
5	1.41 × 4.94 =	7.0	—5
6	0.78 × 4.94 =	4.0	—9
8	0.17 × 4.94 =	1.0	—10
	16.19		

$$U_h = \frac{1}{16.19} = 0.0677$$

0.0677 × (70—[—10]) = 4.94 B.t.u. per sq. ft. per hr.

space drops below 32F, freezing will deposit at least some of the vapor within the space as frost or ice.

The statement has been made that by putting a vapor seal under the plaster base, using some care in lapping and sealing the material at the studding, the problem of condensation would be effectively controlled. Specifically, "the vapor seal should transmit water vapor no faster than 0.40 grains per square meter per hour under a vapor pressure of 18 millimeters of mercury." Table 4 shows the calculations of a wall of ordinary construction with such a vapor barrier under the plaster base. Dry bulb and dewpoint temperatures plotted in Fig. 2 still show an intersection, indicating condensation. Several suggestions to improve conditions might be made, viz., a more porous sheathing, a protective covering of paint porous to vapor but impervious to water, a more effective vapor seal under the plaster or less insulation resulting in a temperature curve that is more convex upward. One or more of these revisions might keep the dewpoint entirely below the temperature.

Concerning the amount of moisture transferred, it is obvious in the two examples shown that the condensation interrupts the steady state, hence the calculations are somewhat in error. Since vapor moves through loose insulation with comparative ease, the vapor pressure drops very little as indicated by the horizontal dewpoint line. Where condensation and freezing occur, the dewpoint, and hence the vapor pressure, drop to correspond to the temperature at which this is occuring, viz., about 2F in Figs. 1 and 2. The vapor pressure at 2F is approximately 0.02 lb. per sq. in., making a difference in vapor pressure across the plaster, and the plaster and the vapor seal, of about 0.13 lb. per sq. in. Following are the calculations for the conditions of ordinary construction and where a vapor seal is used.

For Ordinary Construction

Vapor *into* Stud Space

Through material (2) whose

$$\frac{1}{C_v} = 0.033$$

$$C_v = \frac{1}{0.033} = 30.0 \text{ gr. per sq. ft. per hr. per lb. press. diff.}$$

TABLE 3—TYPICAL CALCULATIONS OF VAPOR PRESSURE DROP THROUGH A COMPOSITE WALL

(Wall having vapor transmission of 0.308 grains per sq. ft. per hr.)

Material (See Table 1)	$\frac{1}{C_v}$	Vap. Press. Drop	0.15†—Cumulative Pressure Drops	Dewpoint‡, F.
1	0		0.15	45
2	0.033 × 0.308 =	0.010	0.14	43
5	0.17 × 0.308 =	0.052	0.088	31.5
6	0.01 × 0.308 =	0.003	0.085	30.5
7	0.10 × 0.308 =	0.031	0.054	21.5
9	0.143 × 0.308 =	0.044	0.010	—10.0
	.456			

$$U_v = \frac{1}{0.456} = 2.19$$

2.19 × 0.15 — 1.010 = .308 grains per sq. ft. per hr.

†Vapor pressure at 45F dewpoint = 0.15 lb. per sq. in.
‡Dewpoint corresponding to vapor pressure in previous column.

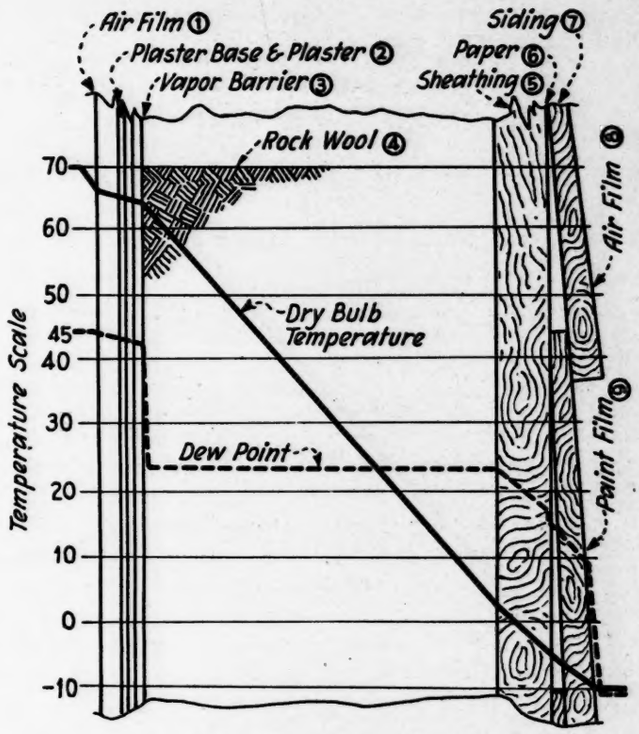


Fig. 2. Plot of temperature gradients through the wall shown in Fig. 1, but with a vapor barrier.

30 × 0.13 lb. press. = 3.9 grains per sq. ft. per hr.

Vapor *out of* Stud Space

For material (5), $\frac{1}{C_v} = 0.17$

" " (6), " = 0.01
" " (7), " = 0.10
" " (9), " = 0.143

0.423

$$C_v = \frac{1}{0.423} = 2.36 \text{ gr. per sq. ft. per hr. per lb.}$$

2.36 × 0.01 lb. = 0.0236 gr. per sq. ft. per hr.

Difference 3.9 — 0.024 = 3.86 gr. per sq. ft. per hr.

Heat Gain, appr. 1000 B.t.u. per lb., or $\frac{1}{7}$ B.t.u. per grain

$\frac{1}{7} \times 3.86 = 0.55$ B.t.u. per sq. ft. per hr.

$\frac{0.55}{4.94} = 11\%$ of heat transfer

For Vapor Seal Construction

Vapor *into* Stud Space

For material (2), $\frac{1}{C_v} = 0.033$

" " (3), " = 0.6

0.633

$$C_v = \frac{1}{0.633} = 1.58 \text{ gr. per sq. ft. per hr. per lb.}$$

1.58 × 0.13 lb. = 0.205 grains per sq. ft. per hr.

Vapor *out of* Stud Space

For material (5), $\frac{1}{C_v} = 0.17$

" " (6), " = 0.01
" " (7), " = 0.10
" " (9), " = 0.143

0.423

$$C_v = \frac{1}{0.423} = 2.36 \text{ gr. per sq. ft. per hr. per lb.}$$

$$2.36 \times 0.01 \text{ lb.} = .0236 \text{ gr. per sq. ft. per hr.}$$

$$\text{Difference} = 0.205 - 0.024 = 0.181$$

$$\text{Heat Gain} = \frac{1}{7} \text{ B.t.u. per grain}$$

$$\frac{1}{7} \times 0.181 = 0.025 \text{ B.t.u. per sq. ft. per hr.}$$

$$\frac{0.025}{4.94} = \text{approx. } \tfrac{1}{2} \text{ of 1\% of the heat transfer}$$

Where a vapor seal is used 1 lb. of ice per square foot might form only after 35,000 hr. of consecutive —10F weather, while without this barrier an equal amount could form in about 2000 hr. or nearly three months. A solid week of this severe weather could produce 1/10 lb. per sq. ft. of condensation.

Whether conditions in actual construction are severe enough to cause the conditions reported without some special aggravating cause is a subject for conjecture. Certainly high humidity, extra porous or cracked plaster on the inside, and too dense building paper or heavy paint coat on the outside, would accent the tendency toward moisture accumulation. A general knowledge of the characteristics of building materials and a more general use of some method of analysis will result in a reduction of trouble reports and lead a trend toward entire satisfaction.

TABLE 4—TYPICAL CALCULATION OF VAPOR PRESSURE DROP THROUGH A COMPOSITE WALL WITH VAPOR SEAL

(Wall having a vapor transmission of 0.133 grains per sq. ft. per hr.)

Material (See Table 1)	$\frac{1}{C_v}$	Vap. Press. Drop	0.15—Cumulative Pressure Drops	Dew-point, F.
1	0		0.15	45
2	0.033 × 0.133 =	0.004	0.146	44
3	0.6 × 0.133 =	0.080	0.062	24
5	0.17 × 0.133 =	0.023	0.0435	16.5
6	0.01 × 0.133 =	0.001	0.042	15.5
7	0.10 × 0.133 =	0.013	0.029	8.5
9	0.143 × 0.133 =	0.019	0.001	—10.0
	1.056			

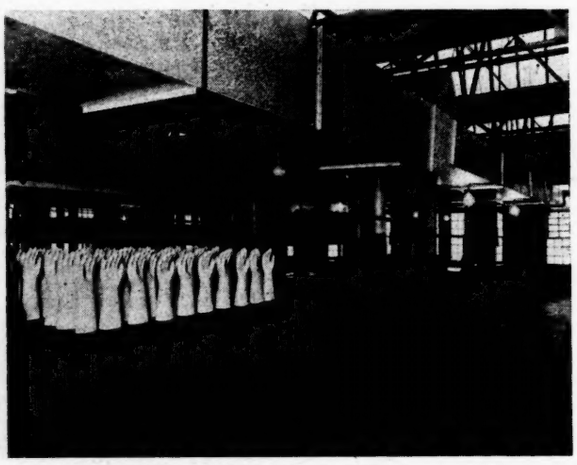
$$U_v = \frac{1}{1.056} = .947$$

$$0.947 \times 0.15 - 0.010 = 0.133 \text{ grains per sq. ft. per hr.}$$

Air Conditioning Aids in the Production of Rubber Gloves

THE Wilson Rubber Co. of Canton, Ohio, world's largest manufacturer of rubber gloves, were handicapped by the weather in the fabrication of electricians' gloves. Linemen who handle high tension wires carrying up to 20,000 volts require a rubber glove that offers complete freedom of movement, yet gives positive protection. To manufacture a glove to meet these standards requires a delicate manufacturing process. A description of this process appeared in a recent issue of Trane Weather Magic. Abstracts follow.

Electricians' gloves are made according to the "Cement Process" which consists of dissolving crude rubber in naphtha to a very thin consistency. The liquid rubber is placed in tanks into which porcelain forms in the shape of the human hand are dipped.



Dipping room showing supply ducts, exhaust ducts (round), dipping tanks containing rubber solution, and racks of forms with electricians' gloves in various stages of manufacture.

After each dipping the naphtha content of the solution must be evaporated so that only a thin deposit of crude rubber remains on the form. The evaporation between dippings requires several hours. About three dozen separate dips are required to produce a finished glove of approximately .055 of an inch in thickness.

Skillful workers of the Wilson Plant knew all the secrets about mixing the rubber and dipping the forms. But after the first dip once was made, they were never exactly sure of the finished product. Old Man Weather might step in causing a temperature change of many degrees or humidity conditions of widely varying percentages before the next step could be made. Such changes could easily ruin a batch of gloves even after most of the 36 dips had been successfully accomplished.

Technicians of the Wilson Rubber Glove Co. determined that a temperature of 85° with a relative humidity of 50% constituted an ideal condition that would insure a perfect finished product. They also determined that a minimum of twelve air changes per hour was necessary in order to carry off the fumes of the naphtha.

To meet these specifications, the Standard Plumbing & Heating Co. of Canton, Ohio, installed a combination of blast coils and an air washer that conditioned 23,000 c.f.m. of outside air. A separate exhaust system, with twenty-four suction lines, each extended to within 2 feet of the floor, was also constructed. This was necessary to pick up the naphtha fumes which are heavier than air and collect at the floor line. 21,000 c.f.m. of room air is exhausted through this system.

A well on the premises provides 290 g.p.m. of 52° water necessary for peak summer operation.

EDITORIALS

FHA Acceptance Standards for Equipment

Insurance of loans made against residential real estate by FHA has been so generally accepted that now FHA occupies a dominant position in residential construction. With this position goes immense power to influence the quality of this construction. Perhaps never before has one organization been so well placed in this respect. The Administration has had certain standards by which it judges the nature of the risk since shortly after it started operations. These have been gradually extended, clarified, and made more definite as time has passed. They seem to have been well prepared and to embody nothing more than these points on which any lender or insurer would want to be informed. Indeed, if anything, the standards have been more sharply criticized as too lenient rather than as too drastic.

Up to this past summer but little was in definite form regarding the minimum performance requirements of heating or air conditioning equipment for FHA insured buildings. During the summer steps were taken to draw up suitable standards. The manufacturers in the industry were generally the ones looked to to produce these requirements. Several of the organized groups of manufacturing interests have had committees at work on this task for some time. The only set of equipment standards to appear up to this time as a result of this effort is the one drawn up by the oil burner group and published in HEATING & VENTILATING in last month's issue.

We do not advocate the adoption of this set of requirements, or an other set which may be drawn up, but we do believe that the thought of definite minimum requirements for heating equipment does have much merit. Naturally, to be acceptable the requirements have to be fair and workable. Naturally, too, it is not a light undertaking to attempt to get such standards drawn up and into full readiness for use. Nevertheless, the possibilities for good are too great to warrant anything less than the very best effort.

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Promotion by Utility Companies

Appearance of another splendid report on air conditioning as a joint effort of two American Gas Association committees serves to bring to mind again the excellent promotional and educational work done by the various utility organizations.

In this particular instance the use of gas for building heating and cooling purposes is the theme but at various times the use of oil burners, stokers, room coolers, air conditioning and humidifying equipment powered by electricity and steam have also brought forth utility reports of great usefulness. Generally, too, these printed reports have been freely and cheerfully made available to the whole heating and air conditioning industry. Frequently, they have been the only authentic source of published operating data, while on a few occasions only have these reports been unduly biased or promotional to an extent which would make them objectionable. Probably no one will ever be able to measure the net effect which the promotional effort of the electric utility companies has had on promoting the use and general acceptance of air conditioning as we practice it today. Certain it is, though, that the effect has been important. In some of the worst years of the depression the utility promotional effort represented a large part of the total.

Of late some of the most important joint gas and electric companies have begun to perceive more clearly that their interests in serving air conditioning and heating loads may call for electric power in some instances and gas or steam power in others. To the extent that this is found to meet the needs of the consumer also, the promotional efforts of the utilities are likely to be diversified—spread out, not curtailed.

And there is still much for them to do, for to a large extent their attitude and their policy toward the nature of power for these loads fix the investigational and product development activities of equipment manufacturers. There is no need to turn out a fine piece of gas-powered equipment, let us say for example, unless, and until, those who furnish the gas are ready to welcome it and help it find its proper place in the whole scheme of things. So also is the application engineer curtailed in his possible scope until suitable equipment is at hand with which he can work and about whose performance he has no qualms. As things stand at present certainly much more is known and much more is available with which to work when electricity is to be the power than when gas, oil, or steam is to be applied. To bring the others up to a similar point is a task in which the utility companies have a large place and a large interest. No one who is far-seeing can fail to catch the point that in the long-range growth of both heating and cooling air for comfort applications there must be a place for all sources of power where each can be most advantageously used.

Let us have more of the kind of utility promotion which consists chiefly of fact-finding and which has already so well proved its value.

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The Chicago Symposium

On November 22 there is to be a symposium on air conditioning in Chicago in which most of the interested technical groups of that city will cooperate. Judging by the number and the impressiveness of the announced list of papers there will be few phases of air conditioning which will not be covered. Just how these Chicago groups are able to get together on programs is something that the corresponding groups in other places might well find out, for the record of the Chicago crowd along these lines is impressive. They seem to be able to work together and get something done. More power to them!

ABSTRACTS of Current Papers, Books and Pamphlets

Third Building Materials Report

The third publication of a series on building materials and structures being published from time to time by the National Bureau of Standards has just been issued. It deals with the suitability of fiber insulating lath as a plaster base, and includes, among other information mainly of value from a structural standpoint, data on the effect of relative humidity on the flexural strength of fiber insulating boards and on the expansion of such boards.

[*"Building Materials and Structures," Report BMS3, by Lansing S. Wells and D. C. Smith. Size 8 x 10½ in.; 17 pages. Published by the National Bureau of Standards, U. S. Department of Commerce, for sale by the Superintendent of Documents, Washington, D. C.; price 10 cents.*]

●

Bituminous Coal Statistics

The collection of statistics relating to the bituminous coal industry formerly carried on by the Bureau of Mines is now under the control of the National Bituminous Coal Commission, which has prepared the chapter on bituminous coal for the Minerals Yearbook for 1938. This chapter is available in a separate publication, which mentions that increasing competition was experienced in 1937 from both coal and gas by the soft coal industry. It mentions specifically that oil burner sales were approximately twice as great as sales of mechanical stokers, indicating further expansion of fuel oil in the domestic heating market.

The booklet contains statistics of production, consumption, and prices of all kinds relating to the bituminous coal industry, including statistics on wages and the labor situation.

[*"Bituminous Coal" (Chapter from Minerals Yearbook 1938, Review of 1937, with final statistics for 1936), by M. E. McMillan, R. L. Anderson, F. G. Tryon and J. W. McBride. Published by the Bureau of Mines; size 6 x 9 in.; 38 pages; for sale by the Superintendent of Documents, Washington, D. C.; price 10 cents.*]

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Air Analysis

In order to help in the prevention of occupational disease and in the protection of industrial health the Air Hygiene Foundation is issuing, for the use of the industrial concerns supporting the Foundation, a series of bulletins on how to combat industrial disease and guard employe health. The two latest bulletins of this series are "Determination of Lead in the Air" and "Identification of Industrial Dusts."

The first bulletin explains that lead dusts, fumes and mists may enter the air when either lead, its alloys or compounds are used or processed. After describing the sources of contaminations the bulletin discusses the collection of dust samples from the air. Following this the methods of analyzing the samples are taken up. The methods described are the volumetric method with Fairhall's Chromate and the colorimetric method with dithizone. The microscopic detection of lead is also described.

The second bulletin deals with the identification of industrial dusts. Since the inorganic materials found in industrial dusts are largely minerals, the chemical analysis of mixtures of such materials will seldom reveal the percentages of the various minerals present. If an optical method is used instead the minerals can be identified by their optical properties. This bulletin recommends the optical method as a basis of the analytical work, supplemented wherever necessary with chemical determination. The petrographic or optical method is described in detail and many illustrations are provided.

[*"Determination of Lead in the Air," Preventive Engineering Series, Bulletin No. 2, Part 6; and "Identification of Industrial Dusts," Preventive Engineering Series, Bulletin No. 2, Part 7. Published by the Air Hygiene Foundation of America, Inc., Pittsburgh, Pa. Paper cover; 6 x 9 in.; 9 pages in the first bulletin and 18 pages in the second bulletin.*]

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Heating in Norris Houses

Acting under authority in the TVA Act, the Tennessee Valley Authority has put experimental electric heating plants into certain of its houses at Norris, Tenn., and has studied the equipment and the installations in operation. As a result of this work this booklet lists a dozen conclusions drawn from the field studies. Among these is that the insulation in a typical Norris house saves 40% of the heat loss of an average frame house of the same size without insulation and that the efficacy of insulating wool appeared to be equal to its theoretical value. The average heat loss in a typical four-room insulated house, unoccupied and without furnishings, kept closed, thermostatically controlled and constantly heated (exclusive of the attic), is equivalent to three kilowatt hours per hour with an average difference of inside and outside temperature of 26 degrees.

Other thermal characteristics of the house are stated to have been as follows:

Average heat loss per degree-hour	403.	B.t.u.
Electrical energy equivalent of above	0.1181	kw-hr.
Heat loss per degree-hour per cubic foot of space heated	0.0761	B.t.u.
Heat loss per degree-hour per square foot of exposure, i.e., walls, windows, floor, and ceiling	0.17	B.t.u.

The authors of this booklet noted that the efficiency of insulating construction appears to increase during cold weather. That is, in the tests the heat loss did

not increase in full proportion to temperature difference. They found a very considerable saving was made in these houses by keeeping the foundation vents closed. The saving was in the order of 21% of the heat loss indicated. It should be noted that the foundation vents were present because there are no basements under the houses.

Technical studies of field operating conditions can be made to yield very good data for both designers and operators. While the impression in reading this booklet is that the tests described did not extend into periods of very severe winters still it is interesting to note that the authors have worked out the coefficient of heat loss and have also set up in their data some indication of how severe the temperature and wind temperatures were as well as some details of the method of construction and insulation used.

[*"Heating at Norris, Tennessee," by Louis Grandgent, Charles F. Ellis, and W. H. Purnell. Published by Tennessee Valley Authority, Department of Regional Planning Studies, Community Planning Division. This publication is limited to 400 copies and was prepared for technicians. It is not available for general circulation. Forty-two mimeographed pages, plus appendix. 9 x 12 in.*]

●

Pressure Losses in Air Ducts

Due to structural difficulties or to changes in the quantity of air being carried, changes in the cross-sectional area of ducts frequently are necessary so that data on pressure losses resulting from such changes are required. While a limited amount of information on this subject is available most of the data now extant were derived from observations on the behavior of liquids. The University of Illinois Engineering Experiment Station recently studied this matter to determine what these shock losses are and to determine the most practical design as used in the construction of diverging sections of ducts. The authors found that the shock losses are the same on both the suction or outlet side of the fan for a common cross-sectional change, that the shock losses in diverging sections are dependent on the included angle between the sides of the section, the smaller losses accompanying the smaller angles, that shock losses in diverging angles over 60° are as great as those occurring in abrupt expansion, that the minimum shock loss in a diverging section is one where the included angle is 7° for all practical purposes, that the shock loss in an abrupt contraction is much less than in an abrupt expansion, and that the coefficients of contraction for air flowing in a duct following an abrupt contraction vary from 0.73 to 0.74.

Numerous other conclusions were reached after this extensive study.

[*"Pressure Losses Resulting From Changes in Cross-Sectional Area in Air Ducts," by Alonzo P. Kratz and Julian R. Fellows. Bulletin No. 300, University of Illinois Engineering Experiment Station. Size 6 x 9 in.; 58 pages; price 65 cents. Obtainable from University of Illinois Engineering Experiment Station, Urbana, Ill.*]

BRIEF REVIEWS

Stories of American Industry. The second in a series of weekly radio talks setting forth stories of typical American industries. [*"Stories of American Industry," Second Series. Published by the United States Department of Commerce. Paper cover; 5¾ x 9 in.; 150 pages; price 20 cents. For sale by the Superintendent of Documents, Washington, D. C.*]

Low Cost Housing. The second of the National Bureau of Standards series on Building Materials and Structures. This one deals with methods of determining the structural properties of low cost house construction. [*"Building Materials and Structures," Report BMS2, Methods of Determining the Structural Properties of Low-Cost House Constructions, by Herbert L. Whittemore and Ambrose H. Stang. Size 8 x 10½ in.; 18 pages; procurable from Superintendent of Documents, Washington, D. C.; price 10 cents.*]

Heat Production of Chicks. Precise and extensive data on the energy metabolism of domestic fowl are needed for engineers designing large poultry plants. Such data are printed on young chickens in this article. [*"Heat Production and Gaseous Metabolism of Young Male Chickens," by Barott, Fritz, Pringle, and Titus, of the Department of Agriculture. The Journal of Nutrition, Vol. 15, No. 2, February, 1938. Reprints are available from the authors at the Animal Nutrition Division, Bureau of Animal Industry, National Agricultural Research Center, Beltsville, Md.*]

Small Homes Manual. A year book on small homes covering all phases from financing to furnishing, and intended for the homeowner and prospective builder. One million copies of this publication will be printed, one-third of which will be sold at 25 cents each on newsstands. The remainder are available for distribution through various factors of the construction industry. [*"Small Home Builders Year Book 1938-1939." Paper cover; 8½ x 11 in.; 64 pages. Printed in 8 colors. Includes 19 house designs. Published by National Small Homes Bureau, Inc., 572 Madison Ave., New York.*]

Boiler Plants. A seventh edition of a handbook giving data and formulas relating to combustion and performance of boilers and boiler room equipment such as super-heaters and chimneys. The book reviews the fundamental principles, gives information on properties of steam and fuels, combustion calculations, losses, heat balance, heat transfer, boilers, superheaters and chimneys and presents many examples. [*"Heat Calculations of Combustion and Boiler Plants," by F. Nuber, seventh edition. Published by R. Oldenbourg, Munich and Berlin, Germany. Cardboard covers; 6¾ x 4 in.; 165 pages; price, 3.80 R.M.; approx. $1.55.*]

Statistics of Building Construction. A study of building construction during 1936 and 1937 as shown by building permits. This bulletin is the third in a series covering building statistics from 1920 to 1937. [*"Statistics of Building Construction, 1920 to 1937," Part III, by Herman B. Byer. Bulletin 650, Bureau of Labor Statistics, U. S. Dept. of Labor; Obtainable from Superintendent of Documents, Washington, 15 cents; size 6 x 9 in.; 86 pages.*]

THE MONTHLY QUIZ

How many of the following teasers can you answer offhand? Only one of the answers given after each question is correct. Check your answers against those appearing on page 66

1. A koniscope is a device for (1) measuring the cone angle of oil flame in a rotary oil burner (2) measuring shock losses of air in a duct system (3) measuring dust in the air (4) indicating modulus of elasticity of structural shapes (5) counting bacteria in air.

2. The wet bulb temperature is a measure of the total heat in the air; the dry bulb a measure of the sensible heat. A measure of the latent heat is the (1) wet bulb temperature (2) dewpoint temperature (3) wet bulb depression (4) specific humidity (5) absolute humidity.

3. The dewpoint temperature is the temperature at which (1) the moisture in the air all condenses out (2) the moisture begins to condense, with additional condensation at lower temperatures (3) the moisture has all condensed out, after beginning at higher temperatures (4) the vapor pressure is equal to the air pressure (5) the weights of air and moisture are equal.

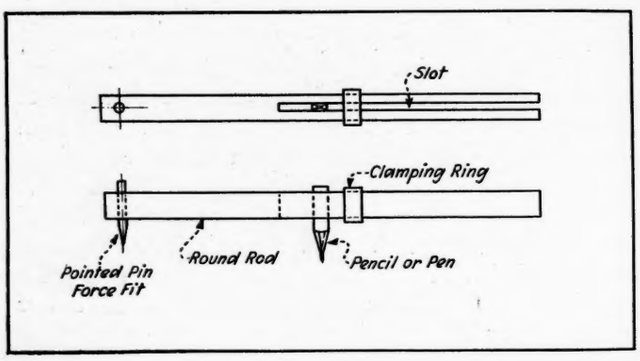
4. The heat loss coefficients as commonly used are based on (1) still air conditions (2) 5 mile per hour wind (3) 10 mile per hour wind (4) 15 mile per hour wind (5) 20 mile per hour wind.

5. Heat loss coefficients are expressed in B.t.u. per unit area per degree temperature difference, and are average results from tests at different temperature differences. Heat loss coefficients at maximum flow conditions (coldest days) are probably (1) about average, or as given (2) somewhat higher than average (3) somewhat below average (4) greatly above average (5) greatly below average.

KINKS

An Inexpensive Beam Compass

A beam compass is an instrument which is badly needed when it is needed, but its infrequent use often makes it undesirable to have a large investment in such a tool. The accompanying drawing illustrates a beam compass made from a round rod with a fixed point made from a forced fitted pin. A pencil is inserted in a flat strip held by pressure from the two sides of the slot which is in turn held by the action of the clamping ring.—*F. C. Holbrook*



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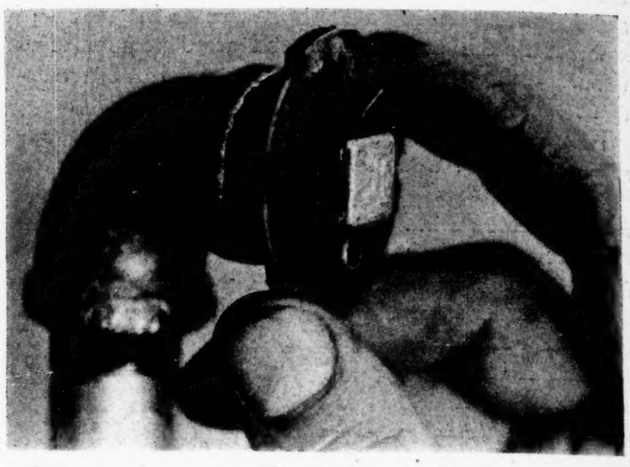
Convenient Handle for Small Pipe Plug

Small pipe plugs are commonly used for air vents, filling and drain openings where they are not firmly turned down into place and an ordinary finger-tight snugness being all that is required. A wrench, however, is always necessary. For such plugs a handy arrangement is shown in the accompanying photograph.



File out the center of a washer so that it will snugly fit and tap down on the square top of the pipe plug. File or grind a number of nicks around the outside for a finger grip and apply a small cotter through the square of the plug to hold the washer handle down in place. With this the plug can be turned in snugly without a wrench, but always taken out, too, without one. The size washer just above that of the plug will be right for the plug square. As illustrated, with a ½-in. plug, a ⅝-in. washer made a neat fit when driven down to the base of the taper of the square top. A ⅛-in. cotter through a hole drilled close to the face of the washer secured it.

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Liberal payment will be made for brief articles which are, in the opinion of the editors, useful and generally applicable kinks relating to drafting room, shop, plant, or field practice in the design, installation, operation, or maintenance of heating, ventilating, or air conditioning equipment. Sketches (in pencil) or photos should be included when necessary.

THE PROBLEM CORNER

In a mill there was a pulley with a rope over it and a 100 lb. weight hanging at each end. A boy came to borrow one of the weights but the man in charge said he could not spare it, since it was necessary to maintain 200 lb. of weight on the pulley. The boy said it would be the same to take off one of the weights and tie that end of the rope to a ring in the floor directly below the pulley. The man disagreed. Who was right?

If you are doubtful of your solution, see page 74.

REFRIGERANTS FOR AIR CONDITIONING—AMMONIA

Temp.	Pressure		Volume		Heat Content		Entropy	
	Lb. per Sq. In.		Cu. Ft. per Lb.		B.t.u. per Lb. Above —40F		Liquid	Total of Vapor
Deg. F	Abs.	Gauge	Liquid	Vapor	Liquid	Total of Vapor		
1	2	3	4	5	6	7	8	9
0	30.42	15.7	0.02419	9.116	42.9	611.8	0.0975	1.8352
2	31.92	17.2	0.02424	8.714	45.1	612.4	0.1022	1.8312
4	33.47	18.8	0.02430	8.333	47.2	613.0	0.1069	1.8273
6	35.07	20.4	0.02435	7.971	49.4	613.6	0.1115	1.8234
8	36.77	22.1	0.02440	7.629	51.6	614.3	0.1161	1.8195
10	38.51	23.8	0.02446	7.304	53.8	614.9	0.1208	1.8157
12	40.31	25.6	0.02451	6.996	56.0	615.5	0.1254	1.8118
14	42.18	27.5	0.02457	6.703	58.2	616.1	0.1300	1.8081
16	44.11	29.4	0.02462	6.425	60.5	616.6	0.1346	1.8043
18	46.13	31.4	0.02468	6.161	62.5	617.2	0.1392	1.8006
20	48.21	33.5	0.02474	5.910	64.7	617.8	0.1437	1.7969
22	50.36	35.7	0.02479	5.671	66.9	618.3	0.1483	1.7933
24	52.59	37.9	0.02485	5.443	69.1	618.9	0.1528	1.7897
26	54.90	40.2	0.02491	5.227	71.3	619.4	0.1573	1.7861
28	57.28	42.6	0.02497	5.021	73.5	619.9	0.1618	1.7825
30	59.74	45.0	0.02503	4.825	75.7	620.5	0.1663	1.7790
32	62.29	47.6	0.02508	4.637	77.9	621.0	0.1708	1.7755
34	64.91	50.2	0.02514	4.459	80.1	621.5	0.1753	1.7721
36	67.63	52.9	0.02521	4.289	82.3	622.0	0.1797	1.7686
38	70.43	55.7	0.02527	4.126	84.6	622.5	0.1841	1.7652
40	73.32	58.6	0.02533	4.048	85.7	622.7	0.1863	1.7635
42	74.80	60.1	0.02536	3.897	87.9	623.2	0.1908	1.7602
43	76.31	61.6	0.02539	3.823	89.0	623.4	0.1930	1.7585
44	79.38	64.7	0.02545	3.682	91.2	623.9	0.1974	1.7552
46	82.53	67.9	0.02551	3.547	93.5	624.4	0.2018	1.7519
48	85.82	71.1	0.02558	3.418	95.7	624.8	0.2062	1.7486
50	89.19	74.5	0.02564	3.294	97.9	625.2	0.2105	1.7453
52	92.66	78.0	0.02571	3.176	100.2	625.7	0.2149	1.7421
54	96.23	81.5	0.02577	3.063	102.4	626.1	0.2192	1.7389
56	99.91	85.2	0.02584	2.954	104.7	626.5	0.2236	1.7357
58	103.7	89.0	0.02590	2.851	106.9	626.9	0.2279	1.7325
60	107.6	92.9	0.02597	2.751	109.2	627.3	0.2322	1.7294
62	111.6	96.9	0.02604	2.656	111.5	627.7	0.2365	1.7262
64	115.7	101.0	0.02611	2.565	113.7	628.0	0.2408	1.7231
66	120.0	105.3	0.02618	2.477	116.0	628.4	0.2451	1.7201
68	124.3	109.6	0.02625	2.393	118.3	628.8	0.2494	1.7170
70	128.8	114.1	0.02632	2.312	120.5	629.1	0.2537	1.7140
72	133.4	118.7	0.02639	2.235	122.8	629.4	0.2579	1.7110
74	138.1	123.4	0.02646	2.161	125.1	629.8	0.2622	1.7080
76	143.0	128.3	0.02653	2.089	127.4	630.1	0.2664	1.7050
78	147.9	133.2	0.02661	2.021	129.7	630.4	0.2706	1.7020
80	153.0	138.3	0.02668	1.955	132.0	630.7	0.2749	1.7991
82	158.3	143.6	0.02675	1.892	134.3	631.0	0.2791	1.7962
84	163.7	149.0	0.02684	1.831	136.6	631.3	0.2833	1.7933
86	169.2	154.5	0.02691	1.772	138.9	631.5	0.2875	1.7904
88	174.8	160.1	0.02699	1.716	141.2	631.8	0.2917	1.7875
90	180.6	165.9	0.02707	1.661	143.5	632.0	0.2958	1.7846
92	186.6	171.9	0.02715	1.609	145.8	632.2	0.3000	1.7818
94	192.7	178.0	0.02723	1.559	148.2	632.5	0.3041	1.7789
96	198.9	184.2	0.02731	1.510	150.5	632.6	0.3083	1.7761
98	205.3	190.6	0.02739	1.464	152.9	632.9	0.3125	1.7733
100	211.9	197.2	0.02747	1.419	155.2	633.0	0.3166	1.7705
102	218.6	203.9	0.02756	1.375	157.6	633.2	0.3207	1.7677
104	225.4	210.7	0.02764	1.334	159.9	633.4	0.3248	1.7649
106	232.5	217.8	0.02773	1.293	162.3	633.5	0.3289	1.7621
108	239.7	225.0	0.02781	1.254	164.6	633.6	0.3330	1.7593
110	247.0	232.3	0.02790	1.217	167.0	633.7	0.3372	1.7566
112	254.5	239.8	0.02799	1.180	169.4	633.8	0.3413	1.7538
114	262.2	247.5	0.02808	1.145	171.8	633.9	0.3453	1.7510
116	270.1	255.4	0.02817	1.111	174.2	634.0	0.3495	1.7483
118	278.2	263.5	0.02827	1.079	176.6	634.0	0.3535	1.7455
120	286.4	271.7	0.02836	1.047	179.0	634.0	0.3576	1.7427
122	294.8	280.1	0.02846	1.017	181.4	634.0	0.3618	1.7400
124	303.4	288.7	0.02855	0.987	183.9	634.0	0.3659	1.7372
126	312.2	297.5	0.02865	0.958	186.3	633.9	0.3700	1.7344
128	321.2	306.5	0.02875	0.931	188.8	633.9	0.3741	1.7316

PROPERTIES OF SUPERHEATED AMMONIA VAPOR

Saturated Vapor		Superheated Vapor					
		Volume Cu. Ft. per Lb.	Heat B.t.u. per Lb.	Entropy B.t.u. per Lb.	Volume Cu. Ft. per Lb.	Heat B.t.u. per Lb.	Entropy B.t.u. per Lb.
Temp.	Press.	50F or Superheat			100F or Superheat		
1	2	3	4	5	6	7	8
0	30.42	10.32	648.0	1.9937	11.42	666.8	1.9999
10	38.51	8.17	643.7	1.9743	9.18	663.0	1.9810
20	48.21	6.72	647.9	1.9560	7.45	659.6	1.9632
30	59.74	5.45	650.8	1.9378	6.04	658.0	1.9459
40	73.32	4.51	654.0	1.9213	5.00	656.7	1.9303
50	89.19	3.74	657.1	1.9097	4.14	655.4	1.9187
		150F or Superheat			200F or Superheat		
0	30.42	12.50	693.5	1.4695	13.56	720.3	1.5317
10	38.51	10.03	697.0	1.4697	10.88	725.0	1.5115
20	48.21	8.15	702.3	1.4511	8.83	729.6	1.4925
30	59.74	6.61	706.6	1.4328	7.16	734.2	1.4744
40	73.32	5.47	710.7	1.4157	5.92	738.6	1.4575
50	89.19	4.53	714.5	1.4000	4.89	742.1	1.4422

Heat Content and Entropy are above minus 40F

AMMONIA (NH_3)

Boiling Point, minus 28.0F Freezing Point, minus 107.8F	Critical Temperature, 271.4F Critical Pressure, 1657 lb. per sq. in.

Approximate Specific Heats (Over Range of Tables)

Liquid, from 1.07 to 1.20; Vapor at constant pressure = C_p = 0.52; and Vapor at constant volume = C_v = 0.401, for C_p/C_v = 1.3

Properties at Common Rating Points

(Without Liquid Sub-Cooling and Without Superheat in Suction, Dry Compression)	Refrig. at 5F Suction	Am Cond. at 86F Suction
	And 86F Condensing Temperature	
Cooling coil (low side) pressure, (lb., abs)	34.27	75.57
Condenser (high side) pressure, (lb., abs)	169.9	169.9
Heat in suction vapor, B.t.u. per lb., (column 7)	613.3	613.3
Heat in liquid before exp. valve, per lb., (column 6 at 86F)	158.9	158.9
Refrigerating effect,[1] (B.t.u. per lb. of refrigerant)	474.4	454.4
Theoretical work of compression,[2] (B.t.u. per lb.)	99.8	99.8
Volume of suction vapor, cu. ft. per lb., (column 3)	8.15	8.15
Theor. lb. of refrigerant, per ton, per min.[3]	4.221	4.411
Theor. piston displ., per ton, per min. (cu. ft.)[4]	3.44	3.60
Horsepower per ton[5]	0.98	0.98
Coefficient of performance, cycle	4.74	4.54
Coefficient of performance, carnot	9.74	10.27

[1]Equals difference between two preceding figures.
[2]By computation, from equating enterpies.
[3]Equals 200 ÷ refrigerating effect.
[4]Product of two preceding figures.
[5]By calculation.

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REFRIGERANTS FOR AIR CONDITIONING—AMMONIA

The data in the several tables of this sheet present in compact form the commonly desired properties of the refrigerant ammonia. The values as tabulated are based on investigational work on the properties of ammonia conducted by the National Bureau of Standards. Ammonia has been used as a refrigerant for so long that its properties have been repeatedly investigated. Consequently, there is little or no variation in the published properties as found in most text and reference books.

Over the range of the tables the value of specific heat of the liquid is a variable, while C_p is used at its mean value of 0.52. For a ratio of C_p to C_v of 1.3, the value of C_v is thus fixed at 0.401.

The saturated table extends over the usual range for air conditioning and much commercial refrigeration work. Both gage and absolute pressures are listed for convenience, with the atmospheric pressure considered steady at 14.7 lb. per sq. in. Volumes of both liquid and vapor are given instead of densities, but the density can be found as the reciprocal of the unit volume when this figure is needed. Entropies are included because of their usefulness in analyzing possible performances.

The superheat table is purposely limited to superheats in the region of the temperature and pressure of the suction vapor, and at the temperatures commonly associated with air conditioning and commercial refrigeration work. Superheat properties over the whole range require more space for tabulation than the frequency of their use seems to justify here.

The various properties tabulated at the common rating points for air conditioning and refrigeration purposes are especially valuable when comparing the characteristics of refrigerants. Many of these figures are also applicable for estimating purposes.

The table giving suitable pipe sizes for use with ammonia, when the cooling load is known, is believed to be amply safe for most air conditioning and refrigeration purposes since the sizes are based on small velocities and low unit pressure drops in the piping.

PIPE SIZES FOR AMMONIA

Nominal Pipe Size In Inches	Vapor Suction Lines		Liquid Lines	
	Cooling Load In B.t.u. per Hour			Lb. of Ammonia per 100 Lin. Ft.
	Refrig. (5F)[1]	Air Cond. (40F)[2]		
⅜				
½				
¾			180,000	3
1	24,000	36,000	360,000	5
1¼	48,000	72,000	720,000	12
1½	96,000	132,000	1,200,000	21
2	144,000	204,000	2,040,000	32
2½	204,000	300,000	3,168,000	46
3	360,000	528,000	5,052,000	82
3½	528,000	736,000	8,160,000	128
4	816,000	1,200,000		
5	1,080,000	1,560,000		
6	1,440,000	2,040,000		
	2,112,000	3,024,000		
	3,264,000	4,800,000		
Max. Velocity f.p.m.	5000	3600	225	
1	2	3	4	5

[1] If suction temp. is under 25F use column headed (5F).
[2] If suction temp. is over 25F use column headed (40F).

NOTE:—Lines ⅜ in. and Less:—Under 25 lin. ft. as tabulated; 26 to 75 lin. ft. use one size larger; 76 to 150 lin. ft. use two sizes larger.

Lines 1 in. to 2 in., Inclusive:—Under 50 lin. ft. as tabulated; 51 to 100 lin. ft. use one size larger; 101 to 200 lin. ft. use two sizes larger.

Lines 2½ in. and Over:—Under 100 lin. ft. as tabulated; 101 to 200 lin. ft. use one size larger; 201 to 300 lin. ft. use two sizes larger.

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NEWS OF THE MONTH

Oil Burner Industry Committee of Six Manufacturers Elected to Formulate FHA Approval Requirements; Porter Resigns

PHILADELPHIA—The meeting of oil burner manufacturers held here Wednesday, October 12, to discuss every angle of the Standards program and test procedures in connection with requirements for approval of burners in FHA financed houses (Title II) was well attended and it was conservatively estimated that manufacturers producing 85% of the volume in the entire industry were represented.

Robert K. Thulman, Mechanical Engineer of the Technical Division of FHA, made a full presentation of the problem of Federal Housing Administration in securing satisfactory oil heating systems in FHA financed houses throughout the country. Mr. Thulman stated that it was essential for FHA to establish minimum standards covering materials and equipment for guidance and it is their hope and preference in every instance that the representatives of each industry establish such standards for them. Otherwise FHA would feel compelled to establish the minimum standards of equipment acceptable, through channels of their own selection outside the industry.

The consensus of opinion of the meeting was that it was most desirable for the industry to establish its own standards and that an industry committee be selected by secret ballot to analyze the standards already recommended by Oil Burner Institute together with proper forms of administering same for best cooperation with FHA. The group also determined that a committee of six could best do this work and voted for this number of members; this committee immediately to prepare its recommendations for report to the burner manufacturing industry which would then be reassembled or polled for final action on the Industry Committee's recommendations.

The result of the industry ballot was the election of the following manufacturers as the Industry Committee:

Silent Glow Oil Burner Corp., Anchor Post Fence Co., Harvey-Whipple, Inc., Reif-Rexoil, Inc., General Electric Co., Air Conditioning Div., and Williams Oil-O-Matic Heating Corp.

Equipment already shipped to Lehigh University should not be recalled. No further equipment should be shipped to Lehigh University until further notice is received from the Institute.

PHILADELPHIA—The Board of Directors of Oil Burner Institute held a regular quarterly meeting here October 11-12.

The October 11 meeting was devoted to a round table discussion of satisfactory equipment standards for the industry and the method to be followed in drawing them up for submission to a general meeting of oil burner manufacturers to be held the next day, October 12.

At the October 12th meeting, G. Harvey Porter submitted his resignation as managing director of Oil Burner Institute to be effective October 31. Mr. Porter explained that he had been contemplating this step for some little time because of the demands of other interests with which he has been closely associated during the past twenty years. Mr. Porter said he had enjoyed his work in the Institute during his term of office dating from July, 1935, and stated that his cooperation in Institute affairs would undoubtedly be continued from time to time through his close interest in the industry. The Board accepted Mr. Porter's resignation and President Dewey said: "I have enjoyed my association with Mr. Porter as well as his respect, consideration and cooperation. He has been energetic, resourceful and loyal and a great help to the Institute. Mr. Porter is leaving with our sincere respect and with the kindest and best wishes of the Institute."

The Board elected to membership in the Manufacturer Division of Oil Burner Institute the Aldrich Co., Peoria, Ill. L. I. Aldrich was then introduced to the Board and invited to sit with it. The provisions of the Wage-Hour Law were briefly discussed for their effect on the oil burner industry and Mr. Ferris, legal counsel, was requested to make a study of the matter. The Board then recessed upon call of President Dewey pending the report of the Industry Committee on Standards.

McLouth Heads Code Committee

COLUMBUS, OHIO—The National Warm Air Heating and Air Conditioning Association has appointed Bruce F. McLouth, Dail Steel Products Co., Lansing, Mich., chairman of the Installation Codes Committee.

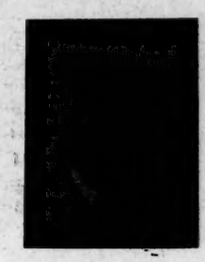
Mr. McLouth has been a member of the Committee for several years and succeeds the late Prof. J. D. Hoffman as Chairman.

Gas Equipment Makers to Meet

NEW YORK—The annual convention of the Association of Gas Appliance and Equipment Manufacturers will be held at the Roosevelt Hotel here May 24-26, 1939. H. N. Ramsey, Gloucester City, N. J., is the chairman of the convention committee.

Mayette Opens New York Office

NEW YORK—Charles E. Mayette, former principal mechanical engineer of the United States Housing Authority, has announced the opening of offices here as consulting engineer specializing in mechanical equipment for large scale housing operations. Mr. Mayette will have affiliations with associated engineers in the principal cities and in addition will act in a consulting capacity in mechanical engineering for USHA.



Charles E. Mayette

Mr. Mayette has specialized for years on central steam service and was connected with the present group heating system for government buildings in Washington. Prior to joining the government he was associated with Stone & Webster, Inc., United Engineers & Constructors, Inc., and American District Steam Company.

In addition to his duties as senior mechanical engineer of USHA, Mr. Mayette has served as a member of the Technical Research Group of the Central Housing Committee at Washington. This is the group which is in charge of the extended research on building materials and structures for use in low-cost housing. This research program is now under way at the National Bureau of Standards. Mr. Mayette continues his membership in this group where he is chairman of the Mechanical Equipment Unit.

Alabama Poly Adds A.C. Laboratory

AUBURN, ALA.—A laboratory within a laboratory is used today in the mechanical engineering department of the Alabama Polytechnic Institute here to demonstrate practical applications of air conditioning to students.

In addition to demonstrations, the air conditioned laboratory will be used for complete tests and research on all aspects of air conditioning. The installation consists of a Carrier all-year system with a bypass and evaporative condenser.

Prof. Charles R. Hixon, head of the mechanical engineering department, reports that air conditioning is creating more interest among students than any type of engineering work. Purpose of the course, he explained, was to allow the student to determine if he wants to follow air conditioning as a lifetime job.

Although Auburn has given courses in heating, ventilation and refrigeration for several years, the subject of air conditioning is a recent addition.

Gas for Air Conditioning Featured at Annual AGA Convention; Comprehensive Committee Report Presented

ATLANTIC CITY, N. J.—Interest in gas for air conditioning purposes was strongly reflected in the prominent place given it at the 20th annual convention of the American Gas Association held here October 10-13. The convention attracted thousands of gas men from all over the world and the plan of dividing the huge program into sectional sessions was followed.

Gas for air conditioning is of greatest interest to gas men in the Industrial Departments of the gas utilities, and papers on that subject were presented at the Industrial Gas Sessions which met on three consecutive afternoons attracting some 250.

Greatest attention to gas for air conditioning centered around the paper "Relative Importance of Dehumidification and Cooling in Summer Comfort Air Conditioning," presented by Chas. S. Leopold, consulting engineer, Philadelphia. Mr. Leopold discussed technical factors which in his opinion are of importance in meeting the problems of comfort air conditioning at the present time. He stated that for equal sensation of warmth or coolness with air motion of 15 to 25 f.p.m. for average persons between the ages of 20 and 70 in health and in the range of conditions where normally clothed people are reasonably comfortable: 1F increase in dry bulb temperature is compensated by approximately:

(a) 7% to 10% decrease in relative humidity;

(b) 9 grains per lb. decrease in absolute humidity;

(c) 0.056 in. mercury decrease in vapor pressure;

(d) 1.1 B.t.u. per lb. decrease in total heat.

He also pointed out that under present conditions commercially, most satisfactory conditions are obtained with relative humidity of from 30% to 55% provided the dry bulb temperature is properly compensated. Assuming 50% relative humidity and reasonably long exposure in the conditioned space, optimum results are secured from 76F to 77½F dry bulb and satisfactory results are secured from 76F to 79F. Obtaining the same effective temperature by lowering humidities will result in an increase in the total heat balance.

He believed that a temperature of 83F with a relative humidity of 30% is the practical upper limit in temperature when taking full advantage of air dehydration.

His interpretations of the experiments thus far made lead him to believe that the magnitude of the entrance shock and the rate of disappearance of perspiration are not appreciably affected by variations in relative humidity from 30% to 60%, providing the effective temperature is constant.

Other speakers at the Industrial Gas sessions included George S. Hawley, president, The Bridgeport (Conn.) Gas Light Co.; Hale A. Clark, Michigan Consolidated Gas Co., and chairman of the Industrial Gas Section; Charles R. Bellamy, Columbia Gas and Electric Corp. and chairman, Industrial and Commercial Air Conditioning Committee; C. George Segeler, AGA.

The Industrial and Commercial Air Conditioning Committee, under the direction of Mr. Bellamy, prepared probably the most comprehensive report on the use of gas in air conditioning practice which has yet appeared. This report, prepared jointly with the Committee of Executives on Air Conditioning, W. C. Beckjord, chairman, is especially outstanding because of the facilities available and also for the high grade of the personnel which contributed to it. Included among the individuals who prepared the report are: Charles R. Bellamy; James C. Patterson, Carrier Corp.; Leon Ourusoff, Washington Gas Light Co.; Kendall B. Castle, Jr., Rochester Gas & Electric Corp.; C. F. Cushing, The Bryant Heater Co.; E. R. Downe, American Gas Products Corp.; W. F. Friend, Ebasco Services Inc.; W. R. Hainsworth, Servel Inc.; H. C. Haroldson, Commonwealth & Southern Corp.; F. M. Johnson, Surface Combustion Corp.; E. P. Kramer, Atlanta Gas Light Co.; Glen Miller, Southern Counties Gas Co.; D. S. Reynolds, Boston Consolidated Gas Co.; John de B. Shepard, Consolidated Gas, Electric Light & Power Co. of Baltimore; G. L. Simpson, Pittsburgh Lectrodryer Corp.; Duncan B. Williams, Carbide & Chemical Corp.; Roy P. Wilson, The Philadelphia Gas Works Co.; W. C. Beckjord, Columbia Gas & Electric Corp.; Eugene D. Milener, American Gas Association; N. C. McGowen, United Gas Pipe Line Co.; Herman Russell, Rochester Gas & Electric Corp.; Frank H. Adams, Surface Combustion Corp.; Arthur F. Bridge, Southern Counties Gas Co.; J. A. Brown, Commonwealth & Southern Corp.; R. L. Fletcher, Providence Gas Co.; Lyle C. Harvey, The Bryant Heater Co.; Henry O. Loebell, Combustion Utilities Corp.; Geo. F. Mitchell, The Peoples Gas Light & Coke Co.; W. T. Rasch, American Gas Products Corp.; Louis Ruthenburg, Servel Inc.; F. J. Rutledge, The United Gas Improvement Co.; March L. Sperry, Washington Gas Light Co.

At the AGA Convention: (Left to right) C. R. Bellamy, Chairman of the Air Conditioning Committee; C. S. Leopold, author of a paper; E. D. Milener, AGA Headquarters; C. George Segeler, AGA Headquarters.

Detroit ASHVE Hears Prof. Rowley

DETROIT—The first meeting of the 1938-39 season of the ASHVE Michigan Chapter was held here October 10. There were approximately 80 members and guests present.

President Linsenmeyer called the meeting to order and asked for roll call, reports of the secretary, the treasurer, and the chairmen of the membership and program committees. Mr. Boales outlined the tentative plans which have been made for the summer meeting of the national society at Mackinac Island on July 2-5 next. The meeting is being sponsored jointly by the Michigan and the Western Michigan Chapters.

Prof. F. B. Rowley, past president of the ASHVE and Director of the Engineering Experiment Station, University of Minnesota, was the guest speaker of the evening. He visited the chapter through the cooperation of the Speakers Bureau.

Professor Rowley is conducting an extensive research at the University on the problems of condensation within walls, and his illustrated lecture presented the information which is now available from this study.

RMA Elects Shipley President

MONTREAL—The Refrigerating Machinery Association, in its annual meeting at the Mount Royal Hotel here in October, unanimously approved standards covering a wide range of ammonia equipment. This marked the completion of the first stage of a broad standardization program embarked upon a year or so ago, and it is now planned that the association's standardization studies will be extended to include Freon equipment. Standards approved at today's meeting are to be released in published form shortly.

W. S. Shipley, president of the York Ice Machinery Corp., York, Pa., was elected president of the association, and J. I. Lyle, president of the Carrier Corp., was elected first vice-president.

Heating, A.C. and Control Courses Offered by Massachusetts

BOSTON — Among several hundred courses offered by the University Extension Division, Massachusetts Department of Education, are several in air conditioning, home insulation and heating, with others to be offered in the second semester.

P. A. L. Foulds, consulting engineer, conducts a Thursday evening course for eight weeks, on practical air conditioning. A Tuesday evening course of 15 lectures, which is also offered by correspondence, is conducted by Raymond U. Fitz, professor of mechanical engineering, Tufts College, and covers air conditioning for industrial and commercial buildings.

Charles A. Cummings, sales engineer, Minneapolis-Honeywell Regulator Company, conducts a course on automatic controls for heating and air conditioning, on Wednesdays, which begins Nov. 16 and continues for eight weeks.

A course on home building and home insulation begins November 15 under the direction of W. Albin Johnson, consultant on oil heating, and Marcus Waldo Keyes, insulation and acoustical engineer, for a period of eight Tuesday evening meetings. Joseph Greenblatt, consulting engineer, again conducts a Thursday evening class for eight weeks on apartment house heating, similar to that of last year, while Mr. Johnson has another eight weeks' course on oil burners. An advanced course will follow this if a sufficient demand for it develops.

Gurney Talks to New York ASHVE

NEW YORK—A crowd of more than 70 members of the ASHVE New York Chapter at the opening meeting of the season on October 17 was greeted by President E. Holt Gurney of Toronto, national president of the Society and president of the Gurney Foundry Co., Ltd. Mr. Gurney in his talk, which featured the evening's program, held close attention as he described the activities and certain features of the present program of the national organization.

He was of the opinion that one of the most important projects which the society could undertake was to educate the public on the true meaning and importance of air conditioning. Also he felt that from an administrative point of view it would be better to rearrange the programs of the president and vice-presidents in such a way that chapter visitation would be by vice-presidents rather than the president

Among those present at the meeting were Walter Fleischer, chairman of the research committee, and F. J. Friedman, president of the Montreal chapter. On hand also to receive the life membership certificates voted them recently were E. A. Vivarttas and J. K. Peacock.

Warm Air Manufacturers Launch Publicity Campaign

COLUMBUS, OHIO—President L. R. Taylor of the National Warm Air Heating and Air Conditioning Association has announced here that a cooperative publicity campaign has been officially launched. The association has engaged the public relations firm of Ames & Norr which will set up at its offices in New York a subsidiary organization to be known as the "Information Bureau of the National Warm Air Heating and Air Conditioning Association." While the bureau will be sponsored and controlled by the association it will operate as a separate unit with its own special funds independently of the other activities or funds of the association. This policy was decided upon because the contributors to the publicity fund represent all branches of the industry and some are not members of the association.

The new information bureau will pay particular attention to educating householders and prospective householders regarding the merits of warm-air heating and air conditioning operated in connection with warm-air installations.

Heilman Addresses Pittsburghers

PITTSBURGH—The October 10 meeting of the ASHVE Pittsburgh Chapter had for its guest speaker R. H. Heilman of the Mellon Institute, who spoke on insulating materials as applied to buildings. His talk covered some of the practical applications of the many kinds of insulations, describing the many kinds available on the market as well as other materials that have been tested but not found practical to use either because of cost or physical limitations of the material. The talk was illustrated with the aid of slides which gave the constants and thermal conductivity of many insulating materials. The permissible investment data chart presented was of special interest in that it illustrated a method to be used in selecting the most economical thickness of insulation to justify its cost and investment.

During the lecture many points were brought up by the questions asked. The meeting ended with a discussion of the new asbestos duct.

Seeks Educational Movies, Lectures

ROCHESTER, N. Y.—Frank L. Wadsworth, Rochester consulting engineer, has been appointed chairman of the Grand Council Educational Committee of the Universal Craftsmen Council of Engineers, an organization composed of Master Masons in good standing. As part of his program Mr. Wadsworth is desirous of securing a list of educational movies, lectures, and similar features put out by equipment manufacturers and which are available for use by his Council.

Air Conditioning Symposium at Chicago in November

CHICAGO—A symposium on air conditioning is being held here on the evening of November 22 starting at 7:30 p.m. The meeting which is being held in the Engineering Building is being sponsored by the Chicago Chapter of the American Institute of Architects, the Illinois Society of Architects, the Western Society of Engineers, the ASHVE Illinois Chapter, The Chicago Association of Consulting Engineers, the Refrigerating Machinery Association, and the Air Conditioning Manufacturers Association.

It is hoped that the 1200 capacity of the Engineering auditorium will be filled with members of these organizations and their guests. Anyone interested in the subject is invited.

The presiding officer is to be John Howatt, chief engineer of the Chicago Board of Education. Speakers include the following:

Prof. Philip Drinker, Harvard University, who will present such topics as what is required for comfort; limits suggested for air conditioning standards with regard to temperature, relative humidity, movement and cleanliness. W. H. Carrier will discuss: what is air conditioning from a lay viewpoint; what is its general history; health and comfort requirements; air conditioning standards (general); air conditioning systems; scientific research; some national figures in air conditioning discoveries; the resulting main problems of air conditioning. Albert Buenger will discuss architectural problems of insulation and constructional features to provide for air conditioning installations; air conditioning costs, their economic features. Charles S. Leopold, "What air conditioning systems are from an engineering standpoint." Elliott Harrington will describe some practical applications of air conditioning with regard to residential buildings, commercial buildings and public assembly rooms. John R. Hertzler will cover refrigeration as applied to air conditioning; and Wm. B. Henderson, secretary, Air Conditioning Manufacturers Association, will offer a broad view of manufacturers products available to the air conditioning industry for human occupancy.

Williams Addresses Junior ASME

NEW YORK—At the opening meeting of the metropolitan Junior Group ASME held here October 11, R. W. Williams of Carrier Corporation spoke on the subject "Principles of Psychrometry." The junior group in the metropolitan district has arranged a series of interesting programs for the year and the subjects selected indicate the increasing interest of the members in air conditioning.

Warm Air Convention to Celebrate 25th Anniversary of Association

COLUMBUS, OHIO—President L. R. Taylor of the National Warm Air Heating and Air Conditioning Association has announced tentative plans for that organization's next convention, which is to be held in the Netherland-Plaza Hotel, Cincinnati, December 12-14. Mr. Taylor emphasizes the fact that at this meeting the silver anniversary of the 25 years of continuous and successful service of the association will be appropriately celebrated, and that business conditions and new developments in the industry will make the sessions of the convention important and helpful to every manufacturer, jobber, dealer, and engineer in the business, all of whom are cordially invited to be present.

According to Allen W. Williams, managing director, a capacity crowd as usual is certain.

Monday, December 12, will be devoted to meetings of the board of directors and committees. The convention sessions open Tuesday, December 13, at 10 a.m.

Some of the other subjects and speakers will be as follows:

Multiple Management, by Charles P. McCormick, Baltimore; a special report from the Installation Codes Committee, B. F. McLouth, chairman; The Standard Test Code for Fans, L. O. Monroe, Detroit; Continuous Blower Operation, G. W. Denges, Cincinnati; Use and Standardization of Pre-Fabricated Ducts, by Perl S. Miller, Columbus; Use of Coke With Warm Air Equipment, H. R. Rost, Cincinnati.

Other speakers include C. B. Hook, president of American Rolling Mills Co. and president of the National Association of Manufacturers, and F. S. Wallace of Federal Housing Administration.

The research session will occupy Wednesday morning and will be in charge of the Research Advisory Committee. Prof. A. P. Kratz will speak on the "Significance of Resistance in a Forced Air System," and Prof. S. Konzo will present a resumé of "Studies of Summer Cooling during 1938."

Tuesday evening the Pavilion Caprice in the Netherland-Plaza Hotel is to be the scene of a banquet and entertainment.

Coal Conference Scheduled for West Virginia University

MORGANTOWN, W. VA.—The School of Mines of West Virginia University here has announced the program for its Combustion Conference on Coal to be held here November 10 and 11. The program as arranged permits time for discussion following each paper presented and is expected to attract a large attendance. The papers on the program follow:

NOVEMBER 10

A.M.

Chairman: J. P. Williams, Jr., President, The Koppers Coal Co.

Scientific Coal Purchasing, T. W. Harris, Jr., E. I. DuPont de Nemours Co.

Discussion, D. T. Buckley, J. G. Bradley, Walter J. Ott.

Latest Developments in By-Product Coke Ovens, C. J. Ramsburg, Koppers Co.

Discussion, J. J. Knight, Howard Zeller.

Evaluation of Various Types of Fuel, Prof. W. A. Koehler, West Virginia University.

Discussion, T. W. Guy, Ellsworth Shriver.

Technique of Fuel Engineering, J. G. Bently, The Johnson-March Corp.

Discussion, L. N. Thomas, H. A. Glover, J. B. Morrow.

Coal's Place in Meeting National Energy Demands, J. V. Sullivan, West Virginia Coal Association.

P.M.

Chairman: Julian D. Conover, The American Mining Congress.

Recent Developments in Coal Research, Dr. H. H. Lowry, Coal Research Laboratory, Carnegie Institute of Technology.

Discussion, H. J. Rose, Lewis Tierney, F. W. Jung, P. Nichols, John C. Cosgrove.

Automatic Heat and Its Control, W. B. Hughes, American Radiator Co.

Discussion, Ernest Webb, A. O. Dady, Frank Hoke.

Service Hot Water Heating, R. E. Moore, Bell & Gossett.

Discussion, J. B. Wallace, H. L. Carson.

How to Select Coal for Various Purposes, Prof. Harry E. Nold, Ohio State University.

Discussion, R. F. Stilwell, Elmer Wierhake, Paul H. Price, H. N. Holloway.

Dustproofing of Coal by Oil Treatment, J. M. Pilcher, Battelle Memorial Institute.

Dustproofing of Coal by Calcium Chloride, Reed Scollon, West Virginia University.

NOVEMBER 11

A.M.

Chairman: J. E. Tobey, Appalachian Coals, Inc.

Planning Good Combustion, C. A. Reed, National Coal Association.

Discussion, C. C. Dickinson, Jr., R. C. Luther.

Coal Preparation, R. E. Salvati, Island Creek Coal Co.

Discussion, D. R. Mitchell, Jos. Pursglove, Henry F. Hebley, C. W. Connor.

Control of Fly Ash, A. C. Fieldner, U. S. Bureau of Mines.

Discussion, W. G. Christy, J. A. Messenger, H. K. Kugel.

Briquetting of Coal by Impact, C. C. Morfit.

Discussion, L. T. Putnam, C. A. Jacobson, P. P. Kerr.

Influence of Transportation on the Future of the Coal Industry, S. C. Higgins, New River Coal Operators Association.

Discussion, T. E. Johnson, M. D. Cooper, George G. Ritchie.

Railroads' Interest in the Coal Industry, George G. Ritchie, C. & O. Railroad Co.

Discussion, George Dunglinson, Jr., W. T. Stringer, G. Murray Campbell.

Customer Turnover, K. C. Richmond, "Coal-Heat."

Discussion, W. A. Richards, E. C. Payne.

P.M.

Chairman: Marc C. Bluth, Stoker Manufacturers Association.

Domestic Stokers, Russell G. Glass, Pocahontas Fuel Co., Inc.

Discussion, Ford R. Cate, J. E. Martin, Thomas A. March, Harry Kennedy.

Extension Instruction in Fuels & Combustion, Prof. Ben G. Elliott, The University of Wisconsin.

Practical Research Conducted by Educational Institutions, Prof. R. S. Hawley, University of Michigan.

Types of Heating Plants, Prof. L. L. Vaughan, North Carolina State College.

Home Owners' Viewpoints, T. I. Coe.

ANSWERS TO QUESTIONS ON PAGE 62

1. (3) is correct
2. (2) is correct
3. (2) is correct
4. (4) is correct
5. (2) is correct

Humanics Subject of Boston Meeting

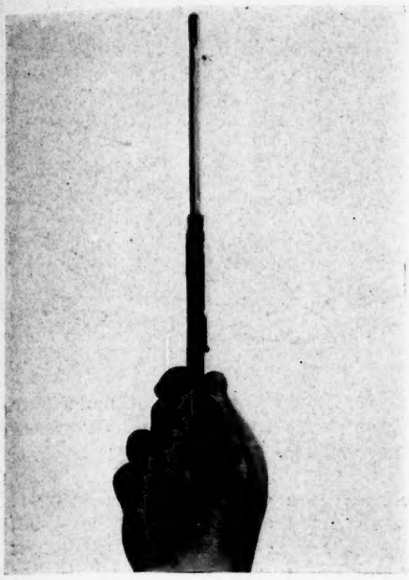
BOSTON—At the first fall meeting of the Air Conditioning Bureau October 20, Prof. F. A. Magoon, associate professor of humanics at Massachusetts Institute of Technology, was the guest speaker. His subject was "Human Relations in Sales and Engineering," a subject that proved highly interesting to the members of the air conditioning industry where sales and engineering are so closely interwoven. Professor Magoon is well known in both engineering and educational circles as an able speaker on the subject of humanics and human relations generally. So interested were those present at the Bureau meeting that a sizable group approached him after the meeting to ask if an evening course in humanics, particularly as applied to sales and engineering, could not be given, either at Tech or as a course in the State University Extension series.

Professor Magoon stated that the study of human relations is the greatest contribution of the present to world civilization and that in years to come it would play a greater part in world affairs. Just as scientific discovery has made incredible progress, although mainly focussed on nature, so will the study of human nature make great progress. We are now in a period of studying ourselves objectively. The first task in any human relations is the solution of problems of conflicts. We must first get the facts, whether one be in conference with a client with a view to installation of air conditioning, the sale of equipment or apparatus, or the settlement of a strike. Sometimes the conflict resolves itself.

In solving problems of conflict one should use the same technique as in putting in a ventilating, heating or air conditioning system. First get the facts; assemble them in logical order; then work out the solution that will satisfy one's own engineering knowledge and experience and the customer's desires and needs. The same procedure applies to any sale or selling problem.

Problems are not truly settled or solved by either domination or compromise. There is dissatisfaction in both. It is necessary to first find all the facts and then apply a solution that is of mutual interest and satisfaction to the parties concerned.

NEW EQUIPMENT



Friez Stack Thermometer

NAME AND MODEL NUMBER—Friez pocket stack temperature thermometer PT/9.

PURPOSE—A thermometer for measuring flue gas temperature and which can be carried in the pocket.

FEATURES — Incorporates reversible combined "case handle" as shown in the illustration. Made from high-temperature glass especially annealed and treated for the purpose. Thermometers are lens-fronted, providing precision reading.

SIZES AND CAPACITIES—In ranges from 30 to 900F in 10F divisions; 7½ in. long.

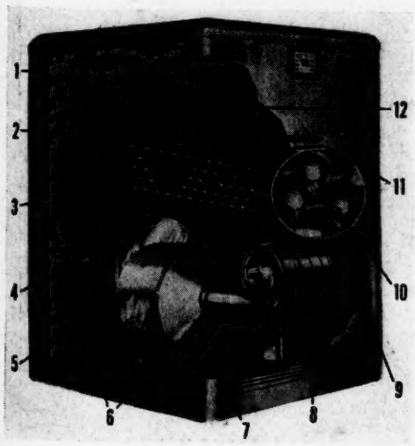
LITERATURE—Catalog Y.

MADE BY—*Julien P. Friez & Sons, Inc., Baltimore, Md.* 1

Delco-Frigidaire Boiler

NAME—Quik-action oil furnace.

PURPOSE—For generating steam and hot water using oil as a fuel.



FEATURES—This oil boiler is a complete boiler-burner unit. The central feature is a metal unit resembling a drum which is built around the area of actual combustion. This unit is called a heat transmitter and is said to reach a temperature of approximately 1500F within 40 to 50 seconds from the time the motor starts. This rapid heating-up period is said to be approximately one-eighth of the conventional time which results in the elimination of fuel wastage represented by incomplete combustion during the long warming-up period. The hot flue gases pass over a network of metal fins directly attached to the walls enclosing the water. These fins are streamlined in design. The manufacturer states that all water channels have been designed to eliminate angles and obstructions of every kind to facilitate rapid water movement. The Delco rotopower unit is standard equipment. In the illustration: (1) refers to the water or steam outlet; (2) the shredder pins; (3) water-backed fins; (4) exhaust end flames traveling upward; (5) streamlined water channels; (6) firebox surrounded by water; (7) heat transmitter; (8) oil burner; (9) thin-mix fuel control; (10) streamlined fins; (11) baffle plate; and (12) salvage fins.

MADE BY—*Delco-Frigidaire Conditioning Div., General Motors Sales Corp., Dayton, Ohio.* 2

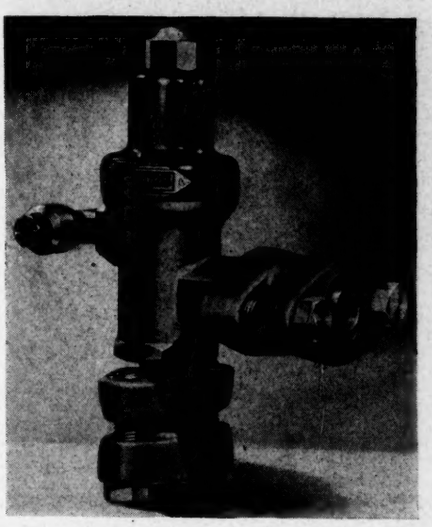
Fedders Constant Pressure Valve

NAME AND MODEL NUMBER—Fedders high capacity constant pressure valve, Model HCP-38.

PURPOSE—Designed for use on air conditioning and large commercial refrigeration installations. By accurately controlling the refrigerant pressure it prevents temperature of the room or cooler from dropping too low and by preventing suction pressure in each coil from falling below the desired point makes it possible to maintain the temperature of different evaporators when connected in multiple to a condensing unit.

FEATURES—A convenient adjusting nut makes it simple to secure the desired pressure. Valve is equipped with a shutoff valve for gage. Large refrigerant passageways and ⅝ in. orifices assure minimum pressure drop through valve. Body made of drop forged brass; moistureproof hermetic seal between body and housing prevents valve from freezing.

SIZES AND CAPACITIES—At an 0.8 lb. per sq. in. pressure drop the capacity is 12,000 B.t.u. per hr.; at 2.3 lb., 24,000 B.t.u.; at 5.8 lb., 36,000 B.t.u.; at 13.5, 48,000 B.t.u.; and at 26.7, 60,000 B.t.u. Inlet and outlet connection flanges are standard equipment



including tail pipes for sweating tubes of from ⅝ in. to 1⅛ in. O.D. Inlet and outlet pipe tap, ¾ in. female.

LITERATURE AVAILABLE—Bulletin 389.

MADE BY—*Fedders Manufacturing Co., Buffalo, N. Y.* 3

Airtherm Unit Heaters

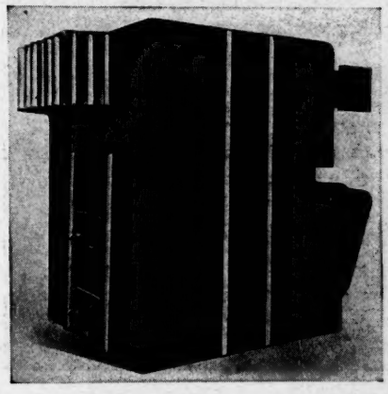
NAME—Directherm unit heaters.

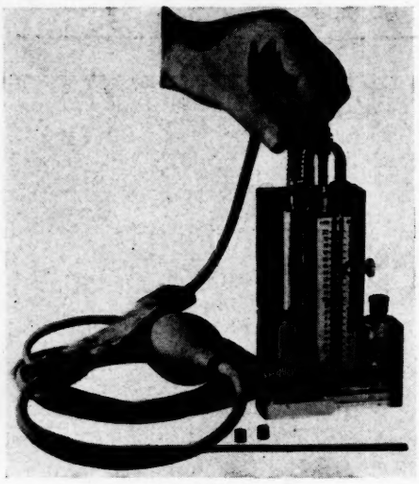
PURPOSE—A direct-fired unit heater for heating buildings whose cost or use justify only the least expensive heating apparatus.

FEATURES—Unit is completely self-contained and is said to be ideal for heating isolated buildings to which it is impractical tc pipe steam for heating purposes. The manufacturer states that the Directherm has a minimum number of parts and gives comparatively low outlet temperatures. A multi-blade centrifugal fan is used to force air through the unit. It is stated that the warm air can be distributed throughout the area without the need of ductwork.

LITERATURE AVAILABLE—Bulletin HV-108.

MADE BY—*Airtherm Mfg. Co., St. Louis, Mo.* 4



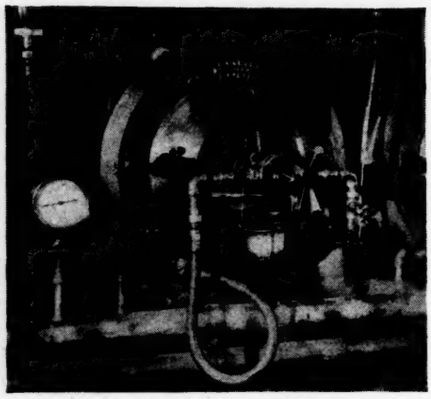


Friez Carbon Dioxide Indicator

NAME—Friez carbon dioxide indicator.
PURPOSE—For indicating carbon dioxide content of flue gas from coal, oil, or gas heating equipment.
FEATURES—Made of a new transparent composition, strong and durable, and is not affected by the caustic solutions used in the indicator. Device is of a small size. Has polished chromium plated, graduated adjustable scale which eliminates errors of parallax. Readings are obtained by lining up the meniscus of the vertical mercury column with the graduations on the adjustable scale and the reflection of the meniscus in that polished scale. Several hundred readings can be made with a single charge of the solution.
LITERATURE—Catalog Y.
MADE BY—*Julien P. Friez & Sons, Baltimore, Md.* 5

Todd Variable Capacity Burner

NAME—Todd variable capacity mechanical pressure atomizing burner.
PURPOSE—For delivering fully atomized oil to combustion chamber.
FEATURES—Manufacturer states that this burner operates with high combustion efficiency over a wide range of firing rates—a range of 20 to 1 or higher—and that this wide range is obtained without changing burner tips, pump delivery pressure, efficiency of atomization at any firing rate, or the angle of spray. Further, this burner is said to maintain constant steam pressure regardless of the demand and that it allows the boiler to follow the sudden and widely varying steam load requirements such as are encountered in both process and heating plants. Burner operates at 300 lb. working pressure. The burner is said to be fully adaptable to automatic control and so designed that any number of burners could be controlled in battery from a single valve. Capacity curve of the burner is said to be a straight line as is the air-flow curve. This straight line permits keeping a constant ratio of fuel to air throughout the entire range of operation. The design is said to be in effect a double burner—a mechanical atomizer, and an ingenious device for reducing the quantity of the atomized oil delivered to the combustion chamber. It is said that this burner permits changing the firing rate instantly, by either manual or automatic means.
SIZES AND CAPACITIES—The single burner has a capacity range from 15 to 1000 lb. of oil per hour.
MADE BY—*Todd Combustion Equipment, Inc., New York.* 6

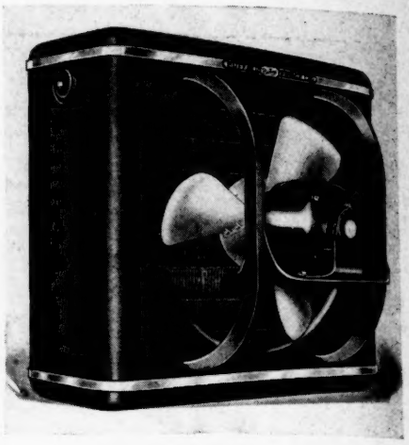


Michigan Chrome Permanent Seal

NAME—Micro Supreme Better Seal Compound.
PURPOSE—A liquid compound to be used as a permanent seal for joints and seams on equipment where gases, oil or steam are encountered.
FEATURES—This compound is said to be insoluble in gasoline, oil, steam or in the various refrigerants such as Freon, methyl chloride, ammonia and sulphur dioxide. The manufacturer states that the compound possesses unusual adhesive properties and is elastic and will withstand severe vibration without cracking. It is said to set quickly and can be applied with either a brush or the fingers.
MADE BY—*Michigan Chrome Co., Detroit, Mich.* 7

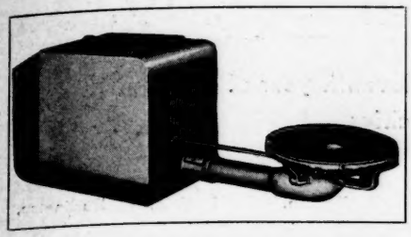
Buffalo Forge Unit Heaters

NAME AND MODEL NUMBER—Breezo-Fin unit heater, Model C.
PURPOSE—For heating air.
FEATURES—Heater element is made of one-piece, seamless copper tubing with square, copper fins, spaced to give maximum radiation. The manufacturer states that because there is only an inlet and discharge joint, both outside of the unit, there is no possibility of leakage inside the unit. The fan is of heavy steel construction and is designed to give increased capacity with less air noise. Louvers are of pressed steel and are curved to deflect the heated air with minimum friction. They are adjustable so that the air may be given any desired deflection. Standard equipment motors are either constant speed single phase, three phase, or direct current. Two-speed motors for single cycle or direct current are available. The casing is streamlined and is finished in a dull luster brown metallic color. Rubber silencers on the motor feet provide for quiet operation. Invisible threaded hangers at top of the unit are said to make installation easy.
SIZES AND CAPACITIES—Five sizes with capacities ranging from 125 to 1083 E.D.R. and air deliveries of 554 to 3550 c.f.m.
LITERATURE AVAILABLE—Bulletin No. 3137.
MADE BY—*Buffalo Forge Co., Buffalo, N. Y.* 8



Reynolds Warm Air Blowers

NAME—Direct Shot warm air circulation blowers.
PURPOSE—Blower for use with warm air heating plants.
FEATURES—The manufacturer states that the mouth is adjustable to any position; that the blowers are quiet and operate without vibration. Speed control is included and blower is belt-driven from an electric motor.
SIZES AND CAPACITIES—Six sizes in capacities from 2500 to 30,000 c.f.m.
MADE BY—*Reynolds Manufacturing Co., Grand Rapids, Mich.* 9



Meier Natural Draft Stoker

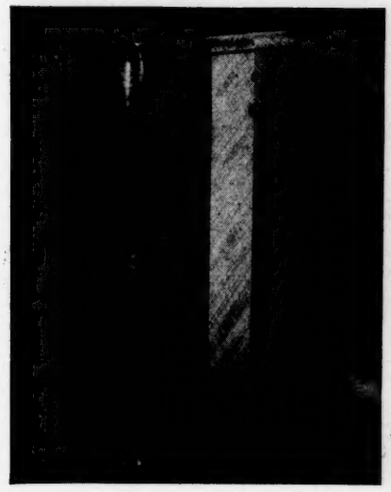
NAME—Meier natural draft stoker.
PURPOSE—For automatically burning stoker size fuels with natural draft.
FEATURES—Stoker operates entirely on a natural draft principle, eliminating the usual fan or blower. The manufacturer states that this eliminates the clinker and fly ash problem. Grates are automatically revolved to keep the fuel bed agitated and to provide a fire burning over the entire grate area. The grates are kept clean by the revolving action which sifts the ashes into receivers placed in the ash pit. The draft is automatically controlled.
MADE BY—*Meier Electric & Machine Co., Indianapolis, Ind.* *10*

Surface Combustion Unit Heater

NAME AND MODEL NUMBER—Large capacity unit heater, No. F1250SC.
PURPOSE—A unit heater for heating industrial buildings with large ceilings. Uses either manufactured, natural, Butane or Propane gas as a fuel.
FEATURES—Unit is of the floor type design 3 ft. in width and 10 ft. 9 in. in length. This small width is said to make it practical to install the heater next to the wall or between columns without taking up any large amount of productive floor space. Unit is 8 ft. 3 in. high and weighs 5200 lb. With the exception of the controls, the unit is shipped completely assembled. Four air outlets, each with horizontal louvers of the adjustable type are provided. Each outlet can be rotated throughout a complete circle permitting discharge of the air in any desired direction. If desired, ductwork may be attached to the outlet. Air is circulated by two fans and a third fan is provided for delivering air to the burner. All fans are driven by a single 7½ hp. motor.
CAPACITY—Input capacity 1,250,000 B.t.u. per hr., output of 1,000,000 B.t.u. per hr.; air delivery 10,000 c.f.m. with an average temperature rise of 125F; air velocity 2500 f.p.m.
LITERATURE AVAILABLE—Bulletin UHF-83.
MADE BY—*Surface Combustion Corp., Toledo, Ohio.* *11*

Westinghouse Air Cleaner

NAME — Portable electrostatic air cleaner.
PURPOSE—A portable air cleaner designed especially for the relief of hay fever and pollen-asthma sufferers but also applicable for general air cleaning in average sized rooms.



FEATURES—Unit depends for its operation upon the cleaning action on gases of a corona discharge. Dirt particles and foreign matter in the air are charged in an ionizing section and then precipitated on the charged plates of the dirt collector cell. Cleaning of the collector cell is accomplished by washing about once every six weeks. Unit may be adjusted to draw in outside air or recirculate the air. Bears approval of Underwriters' Laboratories and the Council on Physical Therapy of the American Medical Association. It is free from radio interference.
SIZES AND CAPACITIES—Operates from 115-volt outlet drawing approximately 80 watts, and circulates 240 c.f.m.
MADE BY—*Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.*.....*12*

Automatic Products Expansion Valve

NAME AND MODEL NUMBER—Thermostatic expansion valve, Model 206.
PURPOSE—A thermostatic expansion valve with factory-set superheat for controlling the flow of refrigerant to small cooling units such as spot room coolers.
FEATURES—Has a small body size, a short capillary tube and a small ⅜-in. bulb so that it may be installed in equipment where a limited amount of space is available. It is said that the thermostatic element is liquid charged so that it is possible to install the valve in a temperature either higher or lower than the bulb temperature. The superheat arrangement is factory-set at 10F. Also available with a range from 5 to 15F. The manufacturer states that the use of this valve is limited to systems or evaporators of known capacity and characteristics, because no field adjustments can be made for individual requirements.
SIZES AND CAPACITIES—Furnished in two orifice sizes giving a ¼ hp. capacity on Freon and a 1/3 hp. capacity on methyl chloride or sulphur dioxide.
LITERATURE AVAILABLE—Bulletin 407B.
MADE BY—*Automatic Products Co., Milwaukee, Wis.* *13*

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below circle the item number of the equipment in which you are interested, using the number found at the end of each item.

1 2 3 4 5 6 7 8 9 10 11 12 13

(This service available only to engineers or executives)

Fill in your name and address, detach and mail to
HEATING & VENTILATING
148 Lafayette St., New York, N. Y.

Name .....

Title .....

Firm .....

Business Address .....

City and State 11/38

Degree-Day Figures for September, 1938

With this issue HEATING & VENTILATING begins its eleventh year of publishing degree-day data for various large cities

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for September, 1938.....	210	17	36	9	114	181	289
Degree-days for September, 1937.....	164	19	61	7	128	181	226
Degree-days for September, Normal...	72	0	0	0	48	75	144

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for September, 1938.....	153	89	58	91	57	53	70
Degree-days for September, 1937.....	162	120	103	134	112	69	90
Degree-days for September, Normal...	240	3	0	27	0	72	0

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for September, 1938.....	139	17	227	0	124	36	82
Degree-days for September, 1937.....	178	26	286	0	154	48	156
Degree-days for September, Normal...	42	0	261	0	36	0	0

	Fort Worth, Tex.	Grand Rapids, Mich.	Green Bay, Wis.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Ithaca, N. Y.
Degree-days for September, 1938.....	0	129	166	87	126	65	224
Degree-days for September, 1937.....	1	164	199	112	154	109	221
Degree-days for September, Normal...	0	57	132	0	48	0	96

	Kansas City, Mo.	Knoxville, Tenn.	La Crosse, Wis.	Lansing, Mich.	Lincoln, Neb.	Little Rock, Ark.	Los Angeles, Calif.
Degree-days for September, 1938.....	40	22	119	181	51	6	0
Degree-days for September, 1937.....	35	20	163	224	54	15	0
Degree-days for September, Normal...	0	0	96	114	0	0	0

	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.
Degree-days for September, 1938.....	39	129	12	113	119	24	114
Degree-days for September, 1937.....	71	160	19	145	166	34	127
Degree-days for September, Normal...	0	87	0	84	93	0	39

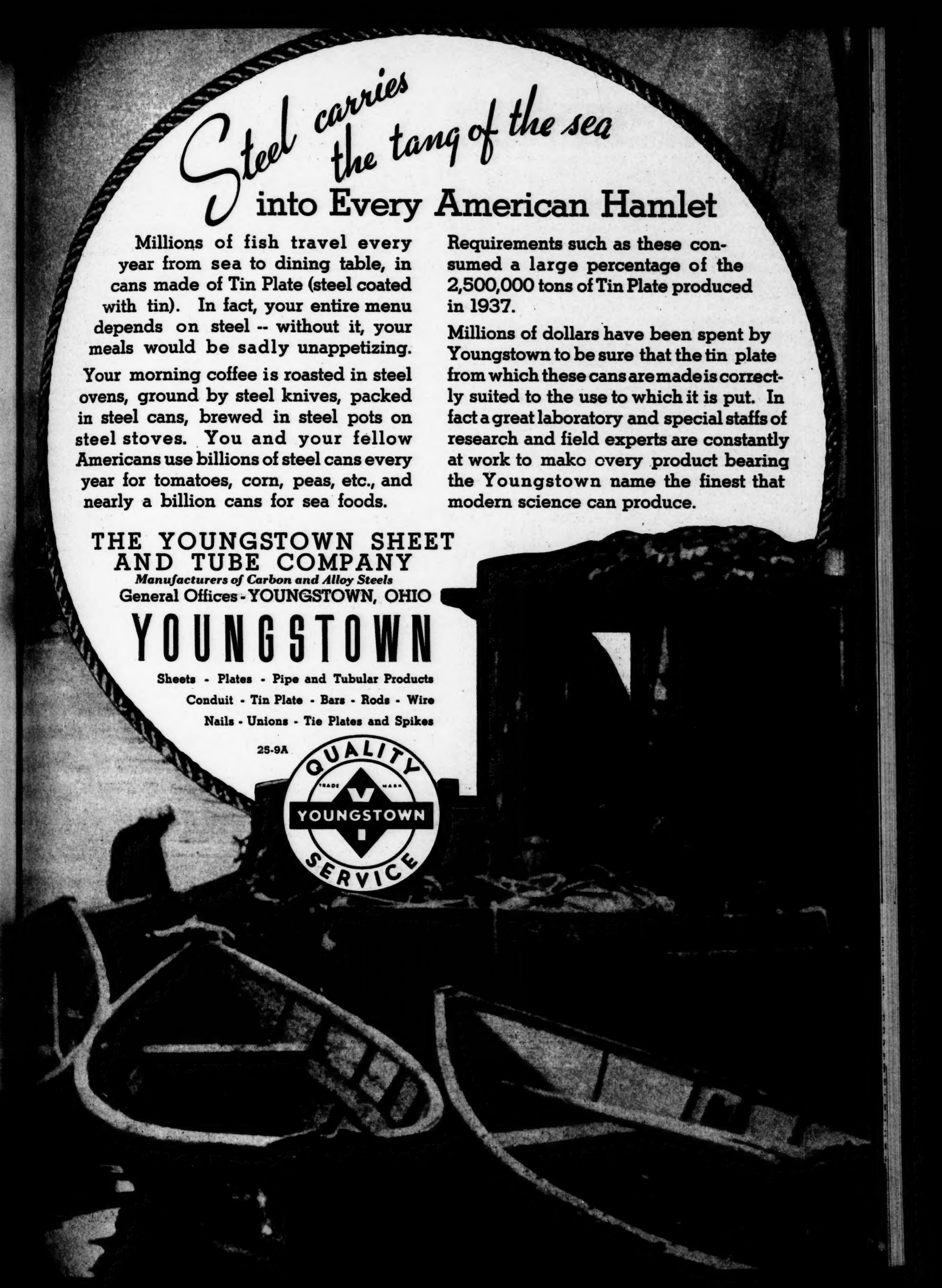
	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma City, Okla.	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.
Degree-days for September, 1938.....	0	53	11	9	59	81	44
Degree-days for September, 1937.....	0	91	16	14	69	115	75
Degree-days for September, Normal...	0	0	0	0	0	3	0

	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.	Reno, Nev.	Richmond, Va.
Degree-days for September, 1938.....	66	195	19	109	89	49	31
Degree-days for September, 1937.....	119	180	89	127	101	76	58
Degree-days for September, Normal...	0	120	105	63	0	144	0

	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.	Spokane, Wash.
Degree-days for September, 1938.....	176	36	7	126	157	64	56
Degree-days for September, 1937.....	196	47	46	134	173	136	138
Degree-days for September, Normal...	72	0	18	114	60	192	192

	Springfield, Ill.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for September, 1938.....	46	199	101	74	233	43	26
Degree-days for September, 1937.....	80	187	161	105	208	78	27
Degree-days for September, Normal...	0	96	9	0	182	0	0

Methods of applying the degree-day in connection with the operation of heating plants or for the prediction of fuel consumption of heating plants are described fully in the new enlarged edition of the DEGREE-DAY HANDBOOK, published by HEATING & VENTILATING, 148 Lafayette Street, New York, price $3. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.


Steel carries the tang of the sea
into Every American Hamlet
Millions of fish travel every year from sea to dining table, in cans made of Tin Plate (steel coated with tin). In fact, your entire menu depends on steel -- without it, your meals would be sadly unappetizing.
Your morning coffee is roasted in steel ovens, ground by steel knives, packed in steel cans, brewed in steel pots on steel stoves. You and your fellow Americans use billions of steel cans every year for tomatoes, corn, peas, etc., and nearly a billion cans for sea foods.
Requirements such as these consumed a large percentage of the 2,500,000 tons of Tin Plate produced in 1937.
Millions of dollars have been spent by Youngstown to be sure that the tin plate from which these cans are made is correctly suited to the use to which it is put. In fact a great laboratory and special staffs of research and field experts are constantly at work to make every product bearing the Youngstown name the finest that modern science can produce.
THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO
YOUNGSTOWN
Sheets - Plates - Pipe and Tubular Products
Conduit - Tin Plate - Bars - Rods - Wire
Nails - Unions - Tie Plates and Spikes
25-9A
QUALITY
TRADE MARK
YOUNGSTOWN
SERVICE

COMING EVENTS

NOVEMBER 10-11, 1938. Coal Conference, School of Mines, West Virginia University, Morgantown, W. Va.

DECEMBER 5-10, 1938. 13th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

DECEMBER 6-8, 1938. 34th Annual Meeting, American Society of Refrigerating Engineers, Hotel Commodore, New York.

DECEMBER 12-14, 1938. Convention and 25th Anniversary, National Warm Air Heating and Air Conditioning Association, Netherland-Plaza Hotel, Cincinnati, Ohio. Allen W. Williams, Managing Director, 50 W. Broad St., Columbus, Ohio.

JANUARY 23-26, 1939. Annual Meeting, American Society of Heating and Ventilating Engineers, William Penn Hotel, Pittsburgh, Pa.

MAY 22-23, 1939. 26th Spring Meeting, American Society of Refrigerating Engineers, Hotel Hershey, Hershey, Pa.

MAY 24-26, 1939. Annual Convention, Association of Gas Appliance and Equipment Manufacturers, Hotel Roosevelt, New York, Association Headquarters, 60 East 42nd St., New York.

MAY 31-JUNE 2, 1939. 50th Annual Convention, Heating, Piping and Air Conditioning Contractors National Association, Drake Hotel, Chicago, Ill. Association headquarters, Room 1401, 1250 Sixth Ave., New York.

JUNE 13-16, 1939. 33rd Annual Convention, Smoke Prevention Association, Hotel Schroeder, Milwaukee, Wis. A Fuel Burning and Air Pollution Exhibition at the Milwaukee Auditorium will be held under the auspices of the Association. C. D. Behan, Publicity Director, SPA, City Hall Sq. Bldg., Chicago.

JULY 2-5, 1939. 45th Semi-Annual Meeting American Society of Heating and Ventilating Engineers, Grand Hotel, Mackinac Island, Mich.

JANUARY 22-26, 1940. 46th Annual Meeting, American Society of Heating and Ventilating Engineers, Cleveland, Ohio. To be held in conjunction with the 6th International Heating and Ventilating Exposition at the Cleveland Public Hall.

JANUARY 23-25, 1940. 35th Annual Meeting, Hotel Cleveland, Cleveland, Ohio.

WITH THE MANUFACTURERS

Aramac Supply Co., 2822 Spring Grove Ave., Cincinnati, has been organized by *J. C. Arata* and *D. H. McDonald, Jr.*, representatives of National Radiator Corporation in Cincinnati for some years. The new company will carry a complete line of heating materials, and will continue to serve as distributor of National products in Cincinnati and adjacent counties.

Bridgeport Brass Co., Bridgeport, Conn., has completed a new rolling mill at Bridgeport for the production of brass, copper and copper-base alloys. Built at a cost of more than $4,500,000, the new plant, in which all rolling mill operations of the company will be located, has a total floor area of more than 220,000 sq. ft.

Conco-Sampsel Stoker Corp., Mendota, Ill., has named the *Great Lakes Coal & Dock Co.*, St. Paul, distributor of its complete line of stokers in the Minnesota and western Wisconsin territories. *L. F. Poirier* will direct the Great Lakes' new stoker department.

Electrol Inc., Clifton, N. J., has appointed the following dealers: *Wm. Crane*, Atlantic City, N. J.; *T. W. Horton*, N. Bennington, Vt.; *Horace R. Moore*, Catskill, N. Y.; *Prospect Garage*, Hartford, Conn.; *Dwight Oil Heat*, Albany, N. Y.; *North Shore Electrol, Inc.*, Manhasset, N. Y.; *E. J. Beacom*, Carmel, N. Y.; *E. D. Coffey*, Kingston, N. Y.; *Dags Systems Associated*, Buffalo, N. Y.; *Automatic Heat Co.*, Lincoln, Neb.

The Emerson Electric Mfg. Co., Inc., St. Louis, Mo., has elected *W. Stuart Symington* president and general manager, succeeding *Joseph Newman*, who will continue as chairman of the board. *Oscar C. Schmitt* continues as vice-president in charge of fan and motor sales; *Raymond E. Otto* is manager of motor sales, replacing L. F. Blough, who resigned; *John Wright* is manager of fan sales, and *E. L. Splitstone* is chief engineer, replacing J. A. Rodgers, who resigned.

Independent Air Filter Co., Chicago, has appointed seven representatives for its air filters: *James L. Brown*, 1824 Galloway St., Memphis, Tenn.; *Crawley-Gorbandt Co.*, 3450 Ivy Rd., NE., Atlanta, Ga.; *Factory Sales & Engineering Co.*, 816 Howard Ave., New Orleans, La.; *K. J. Murray*, 5722 N. 25th Ave., Omaha, Neb.; *W. A. Witheridge Co.*, 746 S. 4th Ave., Saginaw, Mich.; *F. H. Herzsch*, 90 West St., New York, and *Robert Arnold Sales & Engineering Co.*, 2221 N. Broad St., Philadelphia.

Nash-Kelvinator Corp., Detroit, has transferred its commercial division office from Atlanta, Ga., to *Baltimore, Md.*, and added the states of Virginia and Maryland to the Southeastern division. *James A. Lee* heads the enlarged division, replacing *C. D. Taylor*, who has been named sales manager of the standard commercial and liquid cooling department at Detroit. *W. C. Mayfield* has been transferred to Detroit as assistant sales manager of air conditioning and automatic heating, in place of Mr. Lee.

J. Nelson Stuart has been named director of advertising and sales promotion of the company's Kelvinator Division, with headquarters in Detroit. For the past seven years Mr. Stuart was advertising and sales promotion manager of The Delaware, Lackawanna and Western Coal Co.

Refrigerating Machinery Association announces the election of *Carl W. Vollmann*, president, Linde Canadian Refrigeration Co., Ltd., Montreal, as an honorary member of the Association at its annual meeting at the Mount Royal Hotel, Montreal, October 11.

The Research Products Corp., Madison, Wis., has purchased, from the *C. F. Burgess Laboratories, Inc.*, the buildings and land at 1011-1015 E. Washington Ave., Madison, Wis. Officers are: *Howard F. Weiss*, president; *Kemper Slidell*, vice-president; *Max H. Kliefoth*, treasurer; *Milton J. Shoemaker*, secretary; and *Miss Bertha Weisman*, assistant secretary and treasurer.

The Burgess air filter is being manufactured and marketed by the Research Products Corp. under the name of Walton air filter.

Warren Webster & Co., Camden, N. J., has opened a sales office at Newark, N. J., to serve customers in northern New Jersey and Newark and vicinity. The office, in the Globe Indemnity Building, 20 Washington Place, is under the direction of *Edward Mayr* as district representative. Mr. Mayr has been with the New York sales office for 32 years. Assisting Mr. Mayr is *Walter M. Heebner*, sales engineer, and *George J. Schesser*, both previously associated with the Webster Sales office in New York.

Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa., has elected *Frank B. Williams, Jr.*, vice-president in charge of its merchandising division, which handles the merchandising of the company's air conditioning business, with headquarters in Mansfield, Ohio.

Here's Why it Pays to Install

STURTEVANT REXVANE HEATERS

1. **GUARANTEED FOR 200 POUNDS PRESSURE**
   And suitable for all steam pressures up to 200 pounds.
2. **LOW FINAL TEMPERATURES**
   Assure comfort for people near heaters.
3. **GUARANTEED CAPACITIES**
   In accordance with A.S.H.V.E. requirements.
4. **WIDE RANGE OF SIZES**
   Up to 1,421,000 B.T.U. (Standard rating.)
5. **FLEXIBILITY OF APPLICATION**
   All sizes available for either floor, wall or ceiling installation—belt or direct drive.
6. **HIGH EFFICIENCY**
   Large air volume handled with comparative quietness—at high efficiency—and extremely low horse-power.
7. **TIME-SAVING INSTALLATION**
   Sectional construction permits reversal of fan, heating, and center units to meet unexpected piping or other conditions on job.
8. **THERMADJUST CONTROL**
   Optional; either automatic or manual operation.
9. **THREE-BEARING CONSTRUCTION**
   Assures long shaft life. Center bearing easily re-aligned on the job by any mechanic.

We invite you to investigate these Sturtevant Rexvane Heater advantages. Phone our nearest office—or write for Catalog 395-3.

B. F. STURTEVANT CO., Hyde Park, Boston, Mass.
Branch Offices in 40 Cities
B. F. Sturtevant Co. of Canada, Ltd., Galt, Toronto, Montreal

7 Rexvane Heaters selected for Apex Building, Washington, D.C.

Installed in basement garage for general heating and to kill cold drafts at doors.

Deliver total of 1,730,500 B.T.U. and 25,500 C.F.M.

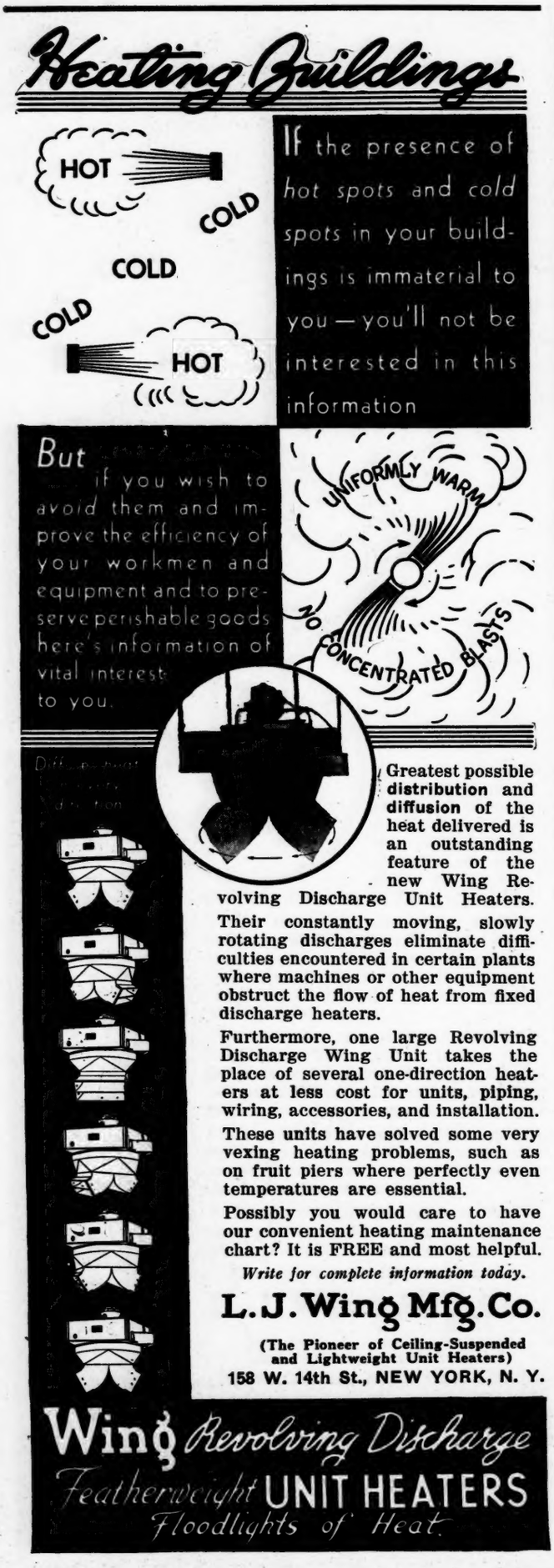
Architect: Bennett, Parsons & Frost, Chicago, in consultation with Procurement Division, Public Works Branch, U. S. Treasury Dept.

General Contractor: McCloskey & Co.

Mechanical Contractor: Mehring & Hanson Co.

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

Fans, Blowers, Air Washers, Air Conditioning, Heating, Vacuum Cleaning, Drying, Mechanical Draft Equipment


Heating Buildings
HOT
COLD
COLD
COLD
HOT
If the presence of hot spots and cold spots in your buildings is immaterial to you — you'll not be interested in this information
But if you wish to avoid them and improve the efficiency of your workmen and equipment and to preserve perishable goods here's information of vital interest to you.
UNIFORMLY WARM
NO CONCENTRATED BLASTS
Greatest possible distribution and diffusion of the heat delivered is an outstanding feature of the new Wing Revolving Discharge Unit Heaters.
Their constantly moving, slowly rotating discharges eliminate difficulties encountered in certain plants where machines or other equipment obstruct the flow of heat from fixed discharge heaters.
Furthermore, one large Revolving Discharge Wing Unit takes the place of several one-direction heaters at less cost for units, piping, wiring, accessories, and installation.
These units have solved some very vexing heating problems, such as on fruit piers where perfectly even temperatures are essential.
Possibly you would care to have our convenient heating maintenance chart? It is FREE and most helpful.
Write for complete information today.
L. J. Wing Mfg. Co.
(The Pioneer of Ceiling-Suspended and Lightweight Unit Heaters)
158 W. 14th St., NEW YORK, N. Y.
Wing Revolving Discharge Featherweight UNIT HEATERS
Floodlights of Heat

Whiting Corp., Harvey, Ill., has appointed *George L. Godfrey*, Elkhart, Ill., manager of its stoker sales in the north and western sections of the country, succeeding J. M. Knox, who was fatally injured in an automobile accident in September. *Sidles Co.*, Omaha, Neb., has been named distributor. *Norman Schwartz* will be in charge of Whiting sales for Sidles.

SUMMER DEGREE-HOURS (ABOVE 85F)* SEPTEMBER, 1938

City	Sept., 1938	Sept., 1937	Year 1938 to Sept. 30	Year 1937 to Sept. 30
Baltimore	45	147	1378	1543
Birmingham	303	57	2296	2789
Bismarck	109	85	1033	1660
Boston	0	73	354	704
Buffalo	0	0	17	27
Chicago	14	122	337	652
Cincinnati	84	121	704	1032
Cleveland	0	6	142	165
Columbus	56	94	969	854
Des Moines	359	375	2455	2488
Detroit	1	65	340	512
Fort Wayne	17	42	353	542
Grand Rapids	0	102	293	980
Houston	497	457	3078	3957
Indianapolis	86	55	671	833
Kansas City	599	499	4904	4975
Memphis	441	90	3002	2057
Milwaukee	1	185	233	694
Minneapolis	5	229	540	1835
New Orleans	229	351	3037	2620
New York	0	47	207	500
Philadelphia	0	100	580	1003
Pittsburgh	2	66	365	538
Portland, Oreg.	61	58	589	208
Richmond, Va.	—	—	—	—
St. Louis	469	125	2952	2368
San Diego	3	14	3	14
San Francisco	4	8	4	9
Savannah	362	164	2963	2260
Toledo	12	43	445	580
Washington	26	133	1192	1279

*Based on data made available through the cooperation of the U. S. Weather Bureau.

ANSWER TO THE PROBLEM ON PAGE 62

The boy was right. Since the reaction by the ring in the floor must equal the pull of the weight, the pull on each side will still equal 100 lb. with the rope tied to the ring.

NEW TRADE LITERATURE

Condensation Pumps. A standard-size, 8-page illustrated bulletin, No. 384, giving dimensions, capacities, and functional description and installation data on the 3500 series, 3700 series, and 3800 series condensation pumps. Installation data include wiring diagrams and foundation dimensions. STERLING ENGINEERING CO., MILWAUKEE, WIS. 14

Fans. For the convenience of engineers and industrial buyers of fan equipment, the National Association

of Fan Manufacturers has available for distribution a leaflet in which is tabulated fair comparison charts of "Planing Mill Exhausters" and "Cast Iron Volume Fans" as well as illustrating the standard methods for arrangement of drive and designation of direction of rotation and discharge. The types of fans mentioned have a wide variety of application in the industrial field such as conveying materials, removing dust and factory waste of a similar nature, handling gases or fumes where the usual type of ventilating fan is not suitable and delivering air at medium pressures. National Association of Fan Manufacturers, Detroit, Mich. 15

Heating Surface. A standard-sized, 48-page catalog, No. 232, illustrating and describing the Nesbitt Series H copper tube and fin heating surface for low and high pressure steam systems. Five pages are devoted to construction features; seven pages to physical data such as types of surface, dimensions, heating surface areas and resistance to air flow; four pages to selection; fourteen pages to tables of capacity; four to temperature rise charts and examples; five to typical systems; and four to piping details. John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa. 16

Ice-Making Equipment. A 32-page booklet of standard size describing methods and systems used in ice making, giving some typical plant layouts and illustrating modern equipment used in ice-making plants. Frick Co., Waynesboro, Pa. 17

Maintenance Checking List. A standard-size, single-page chart with questions regarding maintenance of heating equipment and a place for checking if any item needs looking into. L. J. Wing Mfg. Co., New York.....18

Pumps. Two standard-size bulletins on Sterling pumps. Bulletin No. 40 is devoted to the various types of Sterling vertical centrifugal pumps. Information given includes construction, dimensions, and sizes and capacities. A three-page engineering and hydraulic data section gives data on pipe friction, hydraulic formulas, method of installing and operating vertical centrifugal pumps, locating trouble and pump selection. Catalog No. 42 is devoted to deep well turbine pumps. This bulletin gives construction and installation information, as well as engineering and hydraulic data. Sterling Pump Corp., South Bend, Ind. 19

Relays. A standard-size, 10-page catalog describing the Advance line of relays. Includes information on construction, use and prices of the following types of relays: circuit control, time delay; transmitter; electronic; direct current; mechanically locking electrically reset and overload relays. Advance Electric Co., Los Angeles, Cal. 20

Sheet Metal. An elaborately illustrated 6 x 9 in., 108-page booklet under the title "Bethlehem Sheets, Strip and Galvanized Roofing" bearing catalog number 145. Contains a description of the manufacture of sheets and gives tables of physical properties, weights, gages, and trade customs and instructions for ordering. Bethlehem Steel Co., Bethlehem, Pa. 21

Solenoid Valves. A standard-size, 15-page bulletin, No. S1, illustrating and describing Davis solenoid valves for automatic control service on heating systems, container filling equipment, feedwater make-up lines, refrigeration systems, and boiler feed fuel lines. The types listed are for general service on steam, air, gas, and liquid. Davis Regulator Co., Chicago, Ill. 22

MERCOID CONTROL SECURITY

THE WORD "SECURITY" IS MORE OR LESS A POPULAR EXPRESSION THESE DAYS. WE ALL FIND OURSELVES INVOLVED IN A NATIONAL SOCIAL SECURITY SCHEME. THE SUBJECT HAS BECOME ONE OF WORLD-WIDE AGITATION. ★ THE BASIC IDEA BACK OF IT ALL IS THE ASSURANCE OF PROTECTION. THERE IS AN EVER INCREASING DEMAND FOR THE CERTAINTY OF THINGS AS A WHOLE. ★ PEOPLE ARE NOT SATISFIED WITH SIMPLY KNOWING THAT THEIR REQUIREMENTS ARE ADEQUATELY TAKEN CARE OF FOR TODAY, BUT RAISE THE QUESTION—WHAT OF THE FUTURE? ★ THAT SAME DEMAND IS IMPLIED CONCERNING ALL THE NECESSARY THINGS OF CONSEQUENCE. TO SAY THAT IT LOOKS GOOD OR WORKS ALL RIGHT, IS NOT ENOUGH. THEY EXPECT MORE THAN THAT, AND THIS IS PARTICULARLY TRUE OF AUTOMATIC CONTROLS. ★ A VITALLY IMPORTANT JOB IS ENTRUSTED TO THEIR CARE. MUCH DEPENDS UPON THEM DURING THE LIFE OF ANY AUTOMATIC HEATING EQUIPMENT. ★ IF A CONTROL FAILS, THE AUTOMATIC HEATING EQUIPMENT DOES NOT FUNCTION. SUCH INTERRUPTION BREEDS DISSATISFACTION. ★ MERCOID CONTROLS ARE DESIGNED TO ELIMINATE CAUSES FOR COMPLAINTS. THEIR TYPE OF CONSTRUCTION, DESIGN OF OPERATION, SELECTION OF MATERIALS, SKILLED WORKMANSHIP AND RIGID INSPECTION TESTS ARE ALL MAINTAINED TO A HIGH STANDARD, WITH THE ONE OBJECTIVE:— TO GIVE CONTROL SECURITY

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